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AUSTROBAILEYA

A Journal of Plant Systematics
and
Conservation Biology

Queensland Herbarium
Department of Science, Information Technology, Innovation and the Arts

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A taxonomic revision of *Garcinia* L. (Clusiaceae) in Australia, including four new species from tropical Queensland

W.E. Cooper

Summary

Cooper, W.E. (2013). A taxonomic revision of *Garcinia* L. (Clusiaceae) in Australia, including four new species from tropical Queensland. ***Austrobaileya* 9(1): 1–29.** The genus *Garcinia* is revised for Australia with nine native and three naturalized species included. *Garcinia jensenii* W.E.Cooper, *G. leggeae* W.E.Cooper, *G. russellii* W.E.Cooper and *G. zichii* W.E.Cooper are newly described and illustrated. All species are fully described, together with notes on habitat and distribution. A key to *Garcinia* species in Australia is provided.

Key Words: Clusiaceae, *Garcinia*, *Garcinia brassii*, *Garcinia dulcis*, *Garcinia gibbsiae*, *Garcinia jensenii*, *Garcinia leggeae*, *Garcinia livingstonei*, *Garcinia mangostana*, *Garcinia mestonii*, *Garcinia riparia*, *Garcinia russellii*, *Garcinia zichii*, *Garcinia warrenii*, *Garcinia xanthochymus*, Australia flora, Queensland flora, Northern Territory flora, new species, taxonomy, identification keys, rainforest, naturalised species

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Introduction

Garcinia L. (Clusiaceae) is a pantropical genus of about 260 species (Stevens 2007) of mostly dioecious shrubs and medium sized trees found in Africa, Madagascar, Comoros, the Indian subcontinent (including Bangladesh, Bhutan, India & Sri Lanka), SE Asia (including Cambodia, China, India, Laos, Myanmar, Nepal, Thailand and Vietnam), Malesia (including Malaysia, Indonesia, the Philippines and New Guinea), Solomon Islands, Australia, New Caledonia, Fiji and South America. Species are restricted to various forms of rainforest between the lowlands and the highlands, the exception being *Garcinia amplexicaulis* Vieill. ex Pierre, which occurs in exposed areas and secondary regrowth thickets on degraded and mined areas in New Caledonia. Within Australia, 12 species (nine native, three naturalised) of *Garcinia* occur in Queensland's rainforests and gallery forests from the Torres Strait islands south to the Kirrama Range in the Wet Tropics bioregion, with one species (*G. warrenii*) on Melville Island in the Northern Territory where it occurs in monsoon vine forest. Seven species are endemic to Queensland.

Garcinia plants have been recorded as having white, cream or yellow exudate (Nazre 2006); whereas, some Australian species also have clear or slightly milky exudate. Bracts and glands are a feature of this genus and there are three different types on most species, all are insignificant in species delimitation (Nazre 2006). Fruits are baccate with a single ovule per carpel, a unique combination in *Clusioideae* and a single ovule per carpel is a synapomorphy for the genus (Sweeney 2008: 1298). However, two Australian species, *Garcinia gibbsiae* S.Moore and *G. russellii* W.E.Cooper produce dry berries and commonly contain up to 4 ovules per locule and therefore the presence of a single ovule per carpel is no longer a diagnostic feature for the genus.

The first record of *Garcinia* from Australia was of *G. mestonii* F.M.Bailey (as '*mestoni*') (Bailey 1889), followed quickly by *G. warrenii* F.Muell. (Mueller 1891). The last overall flora account of Australian *Garcinia* enumerated only three species (*G. cherryi* F.M.Bailey [Bailey 1902; subsequently transferred to *Ternstroemia* (Theaceae) as *T.*

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cherryi (F.M.Bailey) J.F.Bailey & C.T.White], *G. mestonii* and *G. warrenii*) (Bailey 1899). Additional species were added by Moore (1917) and White (1933, 1936) and names for Malesian taxa have been variously misapplied to some species; however, the genus has been little studied taxonomically in the intervening years to the present. Consequently, putatively undescribed species known only by phrase names have been recognised in the last twenty years and nine native species were listed for Australia by Cooper & Cooper (2004) and CHAH (2007).

Examination of both live populations of plants and herbarium material, coupled with preliminary phylogenetic analyses of a limited DNA sequence dataset indicate that four undescribed species occur in Australia. Previously, *Garcinia* species endemic to Australia have been named in honour of worthy recipients and this revision continues the tradition by honouring four people who have made valuable contributions to Queensland botany. *G. jensenii* W.E.Cooper is described for material from Cape York Peninsula previously assigned to *G. riparia* A.C.Sm. at CNS. *G. leggeae* W.E.Cooper is described for all of the CNS and some of the BRI material of *G.* sp. (Claudie River) (the remaining BRI material is *G. jensenii*). *G. zichii* W.E.Cooper is described for specimens known as *G.* sp. (Davies Creek) and *G. russellii* had not been recognised by any herbaria but was listed in Cooper & Cooper (2004) as *G.* sp. (Mossman).

Lineages, clades and associated morphology

A phylogenetic analysis of DNA sequence data resolved two major lineages within *Garcinia* (Sweeney 2008). Australia is represented by 12 species (nine native and three naturalised) distributed among 6 clades. Two species occur in Clades 1 & 2 within Lineage A, and ten species occur in Clades 4, 5, 6 & 9 within Lineage B. Lineage A is distinguished by the presence of floral nectaries. Lineage B is distinguished in part, by the lack of disks, appendages and rings (nectaries) (Sweeney 2010: 158).

Sweeney (2008: 1299) in reference to Lineage B, stated that Clades 2 and 4 usually lack a well-developed pistillode. However, using Sweeney's evidence (2008: 1292 and *in litt.*), Clade 2 is part of Lineage A and Clade 4 does have a well-developed pistillode. It is Clade 7 and some species within Clades 5 and 9, which lack a well-developed pistillode.

Clade 1 (*Garcinia dulcis* (Roxb.) Kurz and *G. xanthochymus* Hook.f. [the latter naturalised in Queensland]) is distinguished by 5-merous flowers. Clade 2 (*G. livingstonei* [naturalised in Queensland]) is distinguished by free stamens. Clade 4 (*G. jensenii* and *G. zichii*) is distinguished by fleshy bilocular flowers and fruit, which are capped with a disk-like stigma, unlike the woody pericarp described by Sweeney (2008). Clade 5 (*G.mestonii* and *G. leggeae*) is distinguished by an androecium of fused filaments creating a solitary fleshy receptacle that is not adnate to the petals. Sweeney (2008) stated an additional possible synapomorphy for Clade 5 was the fruit, which usually have furrows along the septal radii, and for Clade 9, the presence of a distinctive adaxial, exudate-containing canal pattern in the leaves, consisting of highly branched, anastomosing canals. In Australian material; however, these characters poorly predict clade membership because furrows (or at least grooves) along the septal radii (putatively synapomorphic for Clade 5) occur in two species from Clade 9 but not in the Clade 5 species. Furthermore, intricately branched exudate-containing canals (putatively synapomorphic for Clade 9: *G. brassii* C.T.White, *G. gibbsiae*, *G. russelli* and *G. warrenii*) are found in *G. dulcis* and *G. livingstonei* (Clades 1 & 2). Clade 6 (*G. mangostana* L.) has no clear morphological synamorphies but is usually distinguished by a fungiform pistillode surrounded by an undivided 4-lobed androecium (Sweeney 2008). Clade 9 in Australian plants is distinguished by an androecium that is adnate to the petals.

Materials and methods

The study is based upon the examination of 521 specimens or photos from BRI, CANB, CNS, K, MEL, NSW and P. All specimens

cited have been seen by the author and all native species have been observed in the field. Naturalised species have been seen in the field and/or cultivation.

Measurements of the floral parts and fruits are based on material preserved in 70% ethanol as well as fresh material from the field; d.b.h. refers to the forestry logging term of diameter at breast height. Abbreviations in the specimen citations are: EP (Experimental Plot), FR (Forest Reserve), LA (Logging Area), NP (National Park), SF/SFR (State Forest/State Forest Reserve) and TR (Timber Reserve). The superscript [1] refers to online images of specimens.

Species are arranged sequentially following the disposition of taxa outlined by Sweeney (2008).

Taxonomy

Garcinia L. *Sp. Pl.* 1: 443 (1753). **Type species:** *G. mangostana* L.

Rheedia L., *Sp. Pl.* 1193 (1753). **Type species:** *Rheedia laterifolia* L. [=*Garcinia humilis* (Vahl) C.D.Adams].

Cambogia L., *Gen. Pl.*, ed. 5:225 (1754). **Type species:** *Cambogia gummi-gutta* L. [=*Garcinia gummi-gutta* (L.) N.Robson].

Oxycarpus Lour., *Fl. Cochinch.* 647 (1790). **Type species:** *Oxycarpus cochinchinensis* Lour. [=*Garcinia cochinchinensis* (Lour) Choisy].

Verticillaria Ruiz & Pav., *Fl. Peruv. Prodr.* 81: t. 15. (1794). **Type species:** *Verticillaria acuminata* Ruiz & Pav.

Xanthochymus Roxb., *Pl. Coromandel* 2: 51 (1798). **Type species:** *Xanthochymus pictorius* Roxb. [=*Garcinia xanthochymus* Hook.f.].

Brindonia Thouars, *Dict. Sci. Nat.* 5: 339 (1804). **Type species:** *Brindonia indica* Thouars. [=*Garcinia indica* (Thouars) Choisy].

Stalagmitis Murray, *Commentat. Soc. Regiae Sci. Gott.* 9: 173 (1789). **Type species:** *Stalagmitis cambogioides* Murray [=*Garcinia ovalifolia* Oliv.].

Hebradendron Graham, *Companion Bot. Mag.* 2: 199 (1837). **Type species:** *Hebradendron cambogioides* Graham [=*Garcinia morella* Desr.].

Discostigma Hassk., *Flora* 25(2, *Beibl.*): 33 (1842). **Type species:** *Discostigma rostrata* Hassk. [=*Garcinia rostratum* (Hassk.) Hook.f.].

Rhinostigma Miq., *Fl. Ned. Ind., Eerste. Bijv.* 3: 495 (1861). **Type species:** *Rhinostigma parvifolia* Miq. [=*Garcinia parvifolia* Miq.].

Pentaphalangium Warb., *Bot. Jahrb. Syst.* 13: 382 (1891). **Type species:** *Pentaphlangium crassinerve* Warb. [=*Garcinia crassinervis* (Warb.) Kosterm.].

***Garcinia* in Australia:** Dioecious or monoecious (agamospermous in the naturalised *G. mangostana*), mostly subcanopy trees but also shrubs or canopy trees to 30 m; exudate, yellow, white or colourless, opaque or translucent. Branchlets square, ribbed or terete; petioles mostly channelled and ligulate. Interpetiolar gland-like bracts at nodes on stems and inflorescences, deltoid, peltate, tiny, caducous, brown. **Leaves** simple, opposite or rarely whorled, coriaceous or chartaceous, shape variable, glabrous; margin entire (or crenate in the naturalised *G. livingstonei*), mostly recurved; venation brochidodromous or paxillate; primary vein raised or flush; exudate-containing canals as parallel or random lines, branched or unbranched, continuous or broken dashes and dots. Inflorescences terminal, axillary or ramiflorous; bracts opposite, leaf-like with a primary vein, occurring at peduncle apex on racemose or paniculate species. Bracteoles mostly opposite, convex or cupular, occurring at pedicel base on most species. Flowers solitary or in cymes, compact panicles, racemes or fascicles, up to 66-flowered; actinomorphic, hypogynous, unisexual, may be fragrant, sessile or pedicellate; sepals 4 or 5, free or joined; petals 4 or 5, free, convex, cupular, erect to almost explanate. **Male flowers:** androecium of fused stamens as phalanges, free stamens or fused filaments as a receptacle, pistillode may be present; anthers mostly bithecate, sessile or with a

short filament. **Female flowers:** staminodal phalanges present or absent; ovary superior, 2–13-locular, 1–4 ovules per locule; stigma sessile or with a short style, discoid or lobed. **Fruit** a fleshy or dry berry, sometimes with seams or furrows along septal radii, 2–13-locular; seeds 1–13, 1–4 per locule; aril present in most species. Germination is hypogeal or epigeal.

***Etymology*:** The generic epithet *Garcinia* is named for the Dutch army doctor and naturalist Laurentius Garcin (1683–1751).

Key to *Garcinia* species in Australia

1 Stigma on flowers and fruit disk-like and entire **2**
1. Stigma on flowers and fruit rayed, lobed or crenate **4**

2 Leaves always opposite; flowers with stamens united as phalanges and surrounding a fungiform pistillode; fruit red or blackish **3**
2. Leaves mostly 3-whorled (occasionally opposite or 4-whorled); flowers with free stamens, pistillode absent; fruit yellow to orange . . . . . **3. *G. livingstonei**

3 Fruit much longer than wide, occurs in the Wet Tropics area . . . . . **5. G. zichii**
3. Fruit equidimensional, occurs north from the McIlwraith Range . . . . . **4. G. jensenii**

4 Seeds and ovules usually more than one per locule **5**
4. Seeds and ovules only one per locule **6**

5 Leaves peltate . . . . . **11. G. russellii**
5. Leaves never peltate . . . . . **10. G. gibbsiae**

6 Exudate in stems and leaves white; petals 5 . . . . . **7**
6. Exudate in stems and leaves yellow; petals 4 . . . . . **8**

7 Secondary veins 20–25 pairs . . . . . **2. *G. xanthochymus**
7. Secondary veins 9–14 pairs . . . . . **1. G. dulcis**

8 Leaves with 10 pairs of secondary veins; exudate-containing canals as short streaks, dashes and dots, unbranched . . . . . **7. G. mestonii**
8. Leaves with 12 or more pairs of secondary veins; exudate-containing canals as continuous long lines **9**

9 Leaves with 2 distinct intramarginal veins . . . . . **8. *G. mangostana**
9. Leaves with 1 intramarginal vein or intramarginal vein absent or not obvious **10**

10 Leaves almost membranous; petals up to 3 mm long . . . . . **6. G. leggeae**
10. Leaves coriaceous; petals 5 mm or more long **11**

11 Leaves with tertiary veins absent . . . . . **9. G. brassii**
11. Leaves with tertiary veins present **12**

12 At least some or most tertiary veins diminishing and not anastomosing . . . . **9. G. brassii**
12. All tertiary veins anastomosing . . . . . **12. G. warrenii**

1. Garcinia dulcis (Roxb.) Kurz, *J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist.* 43: 88 (1874); *Xanthochymus dulcis* Roxb., *Pl. Coromandel* 3: 66 (1820). **Type:** "ex Molucca Islands, cult. In Indian Botanic Garden, Calcutta" *n.v.*; *fide* Maheshwari (1964: 116).

***Illustrations*:** Hooker (1831: t. 3088); Wight (1840: 1: t. 192); van Nooten (1880: t. 15); Christophel & Hyland (1993: 81); Cooper & Cooper (2004: 123); CANBR (2010); Hyland *et al.* (2010); Sompong (2007: 248–250).

Tree to 20 m, dioecious; exudate white in stems and petioles, yellow in fruit; bark with fine vertical fissures, becoming thin flakey on older trees; branchlets square, ribbed, pendulous, glabrous. **Leaves** discolorous, coriaceous, glabrous; petioles 10–30 mm long, channelled, ligulate; lamina elliptic, ovate or oblong-ovate, 75–280 mm long, 32–180 mm wide; base attenuate, cuneate, obtuse, cordate or asymmetrical; apex shortly acuminate, acute or obtuse; margin recurved; venation brochidodromous, primary vein ± flush on upper surface and protruding on abaxial surface; secondary veins 9–14 pairs, raised on both sides in dried specimens, angle of divergence from primary vein 30–60°, forming loops within 1.5–5 mm from margin; exudate-containing canals on upper side are numerous many-branched wriggly lines running more or less parallel to secondary veins, on the underside they are numerous parallel branched or unbranched lines which run at angles between being parallel to primary vein and margin, sometimes running parallel to secondary veins. **Male and female inflorescences** similar, axillary or ramiflorous, a raceme or a fascicle on a pulvinus, 1–many-flowered; bracteoles persistent, clustered at base of pedicels, ovate, convex, keeled, 1–2.25 mm long, 1–2 mm wide, base truncate, apex obtuse or acute, entire, minutely hairy especially around margin, sparsely hairy abaxially. **Male flowers:** fragrant, diameter 11–12 mm, glabrous; pedicels 7–14 mm long; sepals 5, free, orbicular, 2–4 mm long, 3–4 mm long, green, white or cream, margin minutely ciliate; petals 5, free, erect, imbricate, orbicular, convex, 5–7 mm long, 5–7 mm wide, membranous, green, lime-yellow, cream or yellow, glabrous, margin thin and minutely ciliate; androecium 5-phalangiate, glabrous; phalanges antepetalous, strap-shaped at base and flabellate towards apex, introrse, 8–9 mm long, 0.8–1.4 mm wide, apically branched into 5–10 filaments, filaments 0.3–0.7 mm long, 1 anther per filament; anthers bithecate, introrse, broadly-globose, *c.* 0.2 mm long and 0.3 mm wide; disk diameter *c.* 4 mm, pitted or honeycombed; pistillode rudimentary, conical-attenuate *c.* 0.5 mm long. **Female flowers:** fragrant, diameter 8–9 mm; pedicels 9–17 mm long; sepals 5, free, imbricate, orbicular, convex, 3–4.5 mm long, 4.5–6.5 mm wide, green or yellowish, glabrous, margin minutely ciliate; petals 5, free, imbricate, orbicular, convex, 7–8 mm long, 7–8 mm wide, green, cream or yellow, glabrous, margin minutely ciliate; staminodal phalanges 5, antepetalous, solitary and filament-like or 2 or 3-fused, distally inflexed, 2–3.5 mm long, 2 or 3–branched at apex, filaments 0.9–1.4 mm; antherodes 1–3 per phalange, introrse, bilobed, flattened, 0.2–0.3 mm long, *c.* 0.3 mm wide; nectaries alternating between phalanges, *c.* 2 mm long and 2 mm wide, pitted; disk *c.* 4 mm wide; ovary globular, *c.* 5 mm long and 4 mm wide, sessile, 5-locular, locules uniovulate; stigma 5-branched, style *c.* 1.8 mm long; stylar arms 5, *c.* 2.5 mm long. **Fruiting pedicel** *c.* 15 mm long, 5 sepals persistent at base; **fruit** a fleshy berry, ovoid, globular or depressed globular, apex often beaked, 35–50 mm long, 45–53 mm wide, yellow, glabrous; stigma 5-rayed, diameter 2–3 mm; seeds usually 5, *c.* 30 mm long and 20 mm wide; testa brown, smooth; aril fleshy, cream or yellow. *Claudie mangosteen*, *gourka*, *mundu tree*. **Fig. 1A & B, 2B.**

***Additional selected specimens (from 47 examined)*: Malaysia.** KELANTAN: Pasir Putih, Semarak Bt., Sep 1992, *FRI37081* (CNS). **Papua New Guinea.** WEST NEW BRITAIN DISTRICT: 32 km SW of Linga Linga Plantation, May 1973, *Isles & Katik NGF32248* (CNS). MILNE BAY PROVINCE: Esirava Creek, Tagula Island, Mar 1979, *Damas LAE74527* (CNS). **Australia. Queensland.** COOK DISTRICT: Banks Peak, Moa Island, Torres Strait, Jul 2008, *Fell 9722 & Stanton* (BRI); Moa (Banks) Peak, Moa Island, Torres Strait, Feb 1989, *Gray 4993* (CNS); Escarpment of Great Dividing Range, 14.6 km NE of Heathlands Ranger Base, Heathlands D & O Reserve, Oct 1993, *Fell 3746 & Stanton* (BRI); CSIRO Plot, West Claudie River, Dec 2011, *Cooper 2216 & Venables* (CNS); Gordon Creek, Oct 1972, *Hyland 6416* (CNS); Claudie River, Oct 1981, *Hyland 11181* (CNS); Iron Range, base of Lamond Hill, Sep 1988, *Sankowsky 861* (CNS); Nesbit River, Silver Plains Holding, Oct 1999, *Hyland 16253* (CNS); Nesbit River, Silver Plains Holding, Oct 1999, *Hyland 16254* (CNS); Junction of Leo Creek and Nesbit River, Aug 1993, *Fell 3385, Jensen & Barnes* (BRI); Chester River Scrub, Jun 1992, *Forster PIF10440 & Tucker* (BRI); TR 14, Leo Creek Road, Dec 1979, *Hyland 10132* (CNS); TR 14, Leo Creek Mine area, McIlwraith Range, Jun 1992, *Forster PIF10236, Tucker & Kenning* (BRI); Rocky River crossing, Oct 1996, *Cooper 1016 & Cooper* (CNS); Rocky River catchment,

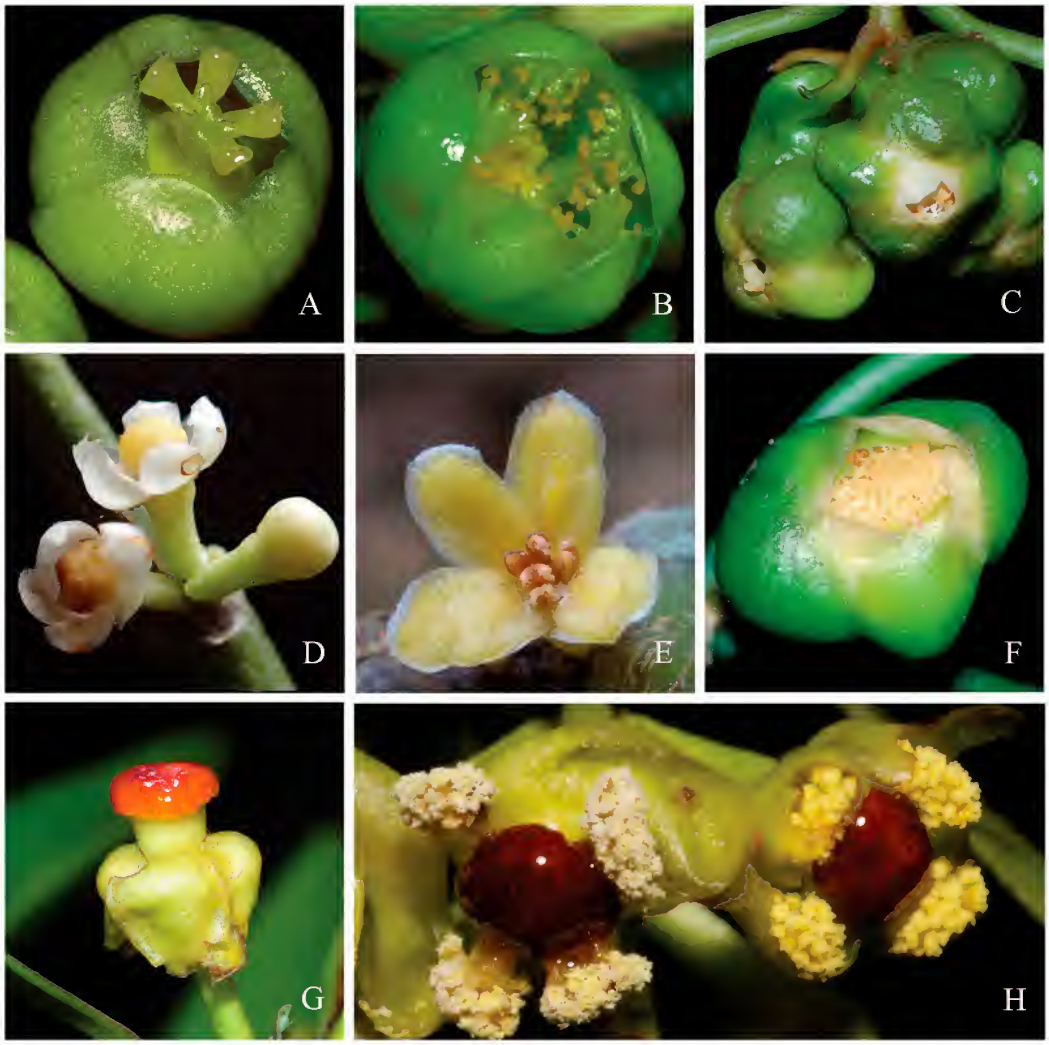


Fig. 1. Flowers. A. ***Garcinia dulcis*** ♀, showing rayed stigma at ovary apex (*Hyland 16253* [CNS]). B. ***G. dulcis*** ♂, showing apically branched phalanges (*Hyland 16254* [CNS]). C. ***G. mestonii*** ♂, showing small opening and anthers (*Sankowsky 2326* [BRI]). D. ***G. jensenii*** ♀, showing 3-flowered inflorescence and yellow stigma at apex of fungiform gynoecium (*Cooper 2225, Zdenek, Venables & Pritchard* [CNS]). E. ***G. leggeae*** ♂ showing anthers (*Cooper 2175, Jensen & Kemp* [CNS]). F. ***G. mestonii*** ♀, showing small opening and stigma (*Forster PIF24028* [CNS]). G. ***G. zichii*** ♀, showing viscous fungiform gynoecium (*Sankowsky 2547* [BRI]). H. ***G. zichii*** ♂, showing viscous fungiform pistillode and anthers at apices of 4-phalangiate androecium (*Dowe 1159* [CNS]). Photos: A, B, F, CSIRO; C, G, *G.Sankowsky*; D, *B.Venables*; E, *R.Jensen*; H, *J.Dowe*.

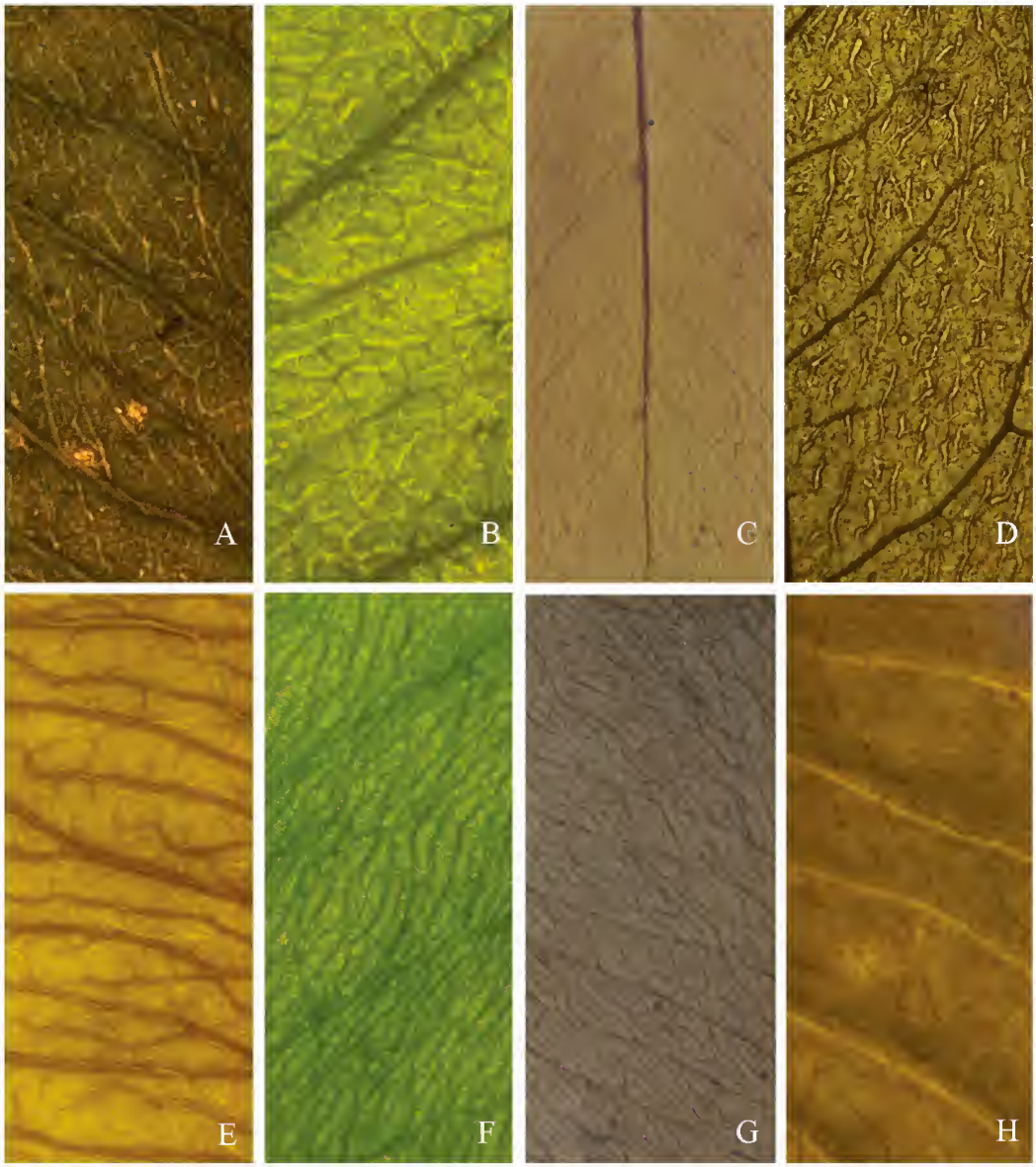


Fig. 2. Exudate-containing canals on leaf undersides shown crossing secondary venation. A. ***Garcinia brassii*** showing as pale lines (*Cooper 2163 & Ford* [CNS]). B. ***G. dulcis*** showing as pale lines and reticulations (*Cooper 2216 & Venables* [CNS]). C. ***G. jensenii*** showing as dark lines (*Cooper 2194, Jensen & Kemp* [CNS]). D. ***G. mestonii*** showing as pale wriggly dashes and dots (*Cooper 2203 & Jensen* [CNS]). E. ***G. gibbsiae*** showing as pale lines (*Cooper 2212* [CNS]). F. ***G. leggeae*** showing as dark lines (*Cooper 2187, Jensen & Kemp* [CNS]). G. ***G. warrenii*** showing as dark lines (*Cooper 474* [CNS]). H. ***G. livingstonei*** showing as dark lines (*Cooper 2218* [CNS]). Photos: A, B, C, D, E, G, H *W.Cooper*; F, *R.Jensen*.

Silver Plains, Aug 1997, *Cooper & Jensen 44* (CNS); Upper Massey (Massy) Creek, Oct 1962, *Smith 11719* (BRI); Melville Range 4 km N of Abbey Peak, Nov 1981, *Irvine 2195* (CNS).

***Distribution and habitat*:** *Garcinia dulcis* is widespread from Australia and New Guinea to South East Asia and India. Within Australia, it is restricted to north Queensland where it occurs in rainforest (complex, semideciduous notophyll and mesophyll vine forest) from the Melville Range on Cape York Peninsula to the Torres Strait islands, altitude 10–500 m (**Map 1**).

***Phenology*:** Flowers have been recorded from September to February; fruit has been recorded from August to October and January to March.

***Etymology*:** The specific epithet is derived from the Latin *dulcis* (sweet or pleasant) referring to the sour but palatable aril.

2. *Garcinia xanthochymus Hook.f. ex T.Anders., *Fl. Brit. India* 1: 269 (1874); *Xanthochymus pictorius* Roxb., *Pl. Coromandel* 2: 51, t. 196 (1805); *Stalagmitis pictoria* (Roxb.) G.Don., *Gen. Syst.* 1: 620 (1831); *Xanthochymus tinctorius* DC., *Prodr.* 1: 562 (1824) [*sphalm.* for *pictorius*]; *Garcinia tinctoria* (DC.) W.F.Wight, *Bull. Bur. Pl. Industr. U.S.D.A.* 137: 50 (1909). **Type:** India: Circars, *s.dat.*, *Roxburgh s.n.* (holo: BR, herb. Mart.).

***Illustrations*:** Roxburgh (1805, 2: t. 196) as *Xanthochymus pictorius* Roxb.; Kirtikar & Basu (1918, 1: t. 104); Sweeney (2008: 1289, K; 2010: 158, 160, 162); Sharma *et al.* (2012: 8, 9).

Shrub or tree to 20 m, dioecious; exudate yellow or milky; bark dark brown, with short vertical fissures, flaky on older trees; branchlets square, mostly pendulous, twigs distinctly 6–8-ribbed. **Leaves** discolorous, coriaceous, glabrous, shiny; petioles 10–25 mm long, ligulate; lamina oblong, linear-oblong, oblong-lanceolate, oblong-ovate or ovate, 120–410 mm long, 38–120 mm wide, base cuneate or rounded; apex acute, acuminate or apiculate; margin recurved; venation brochidodromous, primary vein slightly raised on upper side and distinctly raised on underside; secondary veins 20–25 pairs raised on both sides, angle of divergence from primary vein 50–60°, forming loops within margin, intramarginal vein 0.5–5 mm from margin; exudate-containing canals sparse on the underside as faint long lines running at angles between parallel to the margin and the primary vein. **Male flowers:** not seen for Australian material, recorded as: diameter 15 mm, fascicles 4–8-flowered; sepals 5; petals 5, diameter *c.* 8 mm; androecium 5-phalangiate; phalanges strap-shaped at base and flabellate towards apex, inflexed, apically branched into 3–6 filaments; anthers 2-celled, introrse; nectaries in between phalanges. **Female inflorescences** axillary or ramiflorous, a reduced raceme, fascicle-like, 2–14-flowered. **Female flowers:** fragrance not recorded; diameter 10–12(–20) mm; pedicels (18–)24–36 mm long; sepals 5, free, suborbicular, convex, 3.5–4 mm long, 6–7 mm wide, green or whitish, glabrous, margin minutely ciliate; petals 5, free, orbicular, convex, erect, 7.5–8 mm long, 10–11 mm wide, white, cream or pale yellow, margin minutely ciliate; staminodal phalanges 5, antepetalous, solitary and slender or 3 or 4-fused and strap-shaped at base and flabellate towards apex, inflexed, *c.* 3 mm long, branched into 3 or 4 filaments at apex, filaments 0.5–0.7 mm long, antherodes solitary or 3 or 4 per phalange, introrse, bilobed, flattened, *c.* 0.3 mm long and 0.5 mm wide; nectaries alternating between phalanges, *c.* 2 mm long and 2.5 mm wide, pitted; disk *c.* 5 mm wide; ovary globular, *c.* 4 mm long and 6 mm wide, sessile, 5-locular, locules uniovulate; stigma 5-branched, style *c.* 1.7 mm long; stylar arms 5, 2.5–3 mm long. **Fruiting pedicel** to 40 mm long, sepals persistent at base; **fruit** a fleshy berry, often asymmetrical with beak not centred, ovoid or globose, beaked, 38–65 mm long, 35–50 mm wide, yellow or orange; stigma 5-rayed, diameter 4–5 mm; seeds 1–5 (usually 1 or 2), 25–35 mm long, 15–18 mm wide, testa brown, veined; aril fleshy, yellow or orange. *sour mangosteen*, *false mangosteen*, *yellow mangosteen*, *gamboge tree*, *eggtree*.

***Additional selected specimens (from 6 examined)*: Australia. Queensland.** Cook District: Tributary of

Bushy Creek, Rumula, Oct 1998, *Holmes 66* (CNS); Cultivated, Cairns Botanic Gardens, Feb 2013, *Cooper 2217, Cooper & Venables* (CNS); Wadda Creek, East Palmerston, Sep 1941, *Wilson s.n.* (CNS); Patrick Road off Dunne Road, East Palmerston, Dec 2005, *Jensen 1486 & Cauley* (BRI); Tully, Dec 1945, *Shearer s.n.* (CNS). North Kennedy District: Delta, 3 miles [5 km] W of Bowen, Nov 1971, *Wright s.n.* (BRI [AQ313]). Moreton District: Rosemount Road, Nambour, Nov 1989, *Bruford s.n.* (BRI [AQ458316]).

***Distribution and habitat*:** *Garcinia xanthochymus* is a native of Bangladesh, Bhutan, Cambodia, China, India, Laos, Myanmar, Nepal, Thailand and Vietnam. It is cultivated for its edible sour fruit and has become naturalised in a few locations in Queensland from the Rumula area south to Nambour (**Map 6**), altitude 20–500 m.

***Phenology*:** Flowers have been recorded from February to May. Fruit has been recorded from February to May, November and December.

***Typification*:** *Garcinia xanthochymus* was named by Anderson in Hooker's *Flora of British India* (1874); however, nomenclature for this species commenced nearly 70 years earlier when Roxburgh (1805) described *Xanthochymus pictorius* Roxb. (non *Garcinia pictoria* Roxb.). De Candolle (1824) did not help the situation by totally misprinting (or perhaps 'correcting') the epithet as *X. tinctorius* DC. (Maheshwari 1964; Singh 1993). Anderson (1874) interpreted de Candolle's (1824) account as a misspelling, so coined the new name *G. xanthochymus* with Roxburgh's *X. pictorius* and de Candolle's *X. tinctorius* both in synonymy.

Much later, D'Arcy (1980) overlooked the name *Garcinia pictoria* Roxb. and published the superfluous new combination *G. pictorius* (Roxb.) D'Arcy based on *Xanthochymus pictorius* Roxb.

Anderson (1874) did not unambiguously specify a type collection for *Garcinia xanthochymus*, but did list *X. pictorius* Roxb. and the misprinted *X. tinctorius* DC. in synonymy, together with references to other literature and one specimen in the Wallich Catalogue (no. 4837). Under the distribution notes for this species Anderson (1874) cited a single specimen collected by Roxburgh from the Circars. Maheshwari (1964) listed the type for *G. xanthochymus* as this Roxburgh collection (deposited in BR) and this interpretation appears to have been universally accepted by later authors (Kostermans 1980; Singh 1993).

***Notes*:** Sharma *et al.* (2012) suggested that *G. xanthochymus* produces bisexual flowers; however they concluded that functional bisexuality had not been confirmed. Agamospermy is known or suspected for ten *Garcinia* species (not including *G. xanthochymus*) (Richards 1990a). Separate male and female flowers have been observed and illustrated by Sweeney (2010).

***Etymology*:** The specific epithet is derived from the Greek *xanthos* (yellow) and *chymos* (sap); referring to the exudate.

3. *Garcinia livingstonei T.Anders., *Bot. J. Linn. Soc.* 9: 263 (1866). **Type:** cult. In hort. bot. Calcutta. ex Mozambique, "in rupibus schistosis prope flumen Zambesi", *s.dat.*, *Kirk s.n.* (holo: CAL); *fide* Robson (1960: 400).

***Illustrations*:** Sweeney (2008: 1289, Q).

Shrub or tree to 18 m, monoecious; exudate yellow or reddish; bark grey and rough with numerous vertical fissures; branches terete, arching. **Leaves** discolorous, opposite or 3–4-whorled, coriaceous, glabrous; petioles 2–7 mm long, channelled, ligulate; lamina oblong, elliptical or oblanceolate, 35–110 mm long, 20–55 mm wide; base cuneate, rounded or cordate; apex acute, rounded, emarginate or apiculate; margin crenate or entire, recurved; venation brochidodromous, primary vein raised in a groove adaxially and distinctly raised abaxially; secondary veins 9–15 pairs, pale yellow, raised on both surfaces, angle of divergence from primary vein 60–70°; intramarginal vein merges with margin; exudate-containing canals on upperside are numerous branched lines ± parallel to secondary veins, on the lower side they are branched lines running at angles between the primary vein and margin. **Male and female inflorescences:** similar, axillary or ramiflorous, a fascicle, 2–7-flowered; bracteoles ± quadrate or rhombic, slightly convex, 1–1.5 mm long, 1–1.5 mm wide, base truncate, apex acute, margin 3-toothed,

glabrous. **Male flowers:** fragrant, diameter 8–10 mm; pedicels 6.5–8 mm long, softly muricate; sepals 4, 2-whorled, free, D-shaped, *c.* 1 mm long and 1.8 mm wide, green, margin entire; inner pair orbicular, convex, *c.* 2 mm long and 2.5 mm wide, green or yellowish-green, margin entire; petals 5, free, orbicular, reflexed, 4.5–5.5 mm long, 3.5–4.5 mm wide, membranous, green or greenish-yellow, glabrous; androecium a globose yellow disk with *c.* 30 free stamens radiating like needles in a pin cushion, disk sunken directly below each stamen, filaments 1.5–1.7 mm long; anthers bithecate, globose, diameter *c.* 0.3 mm; pistillode absent. **Female flowers:** fragrant, diameter *c.* 7 mm; pedicels 16–20 mm long, softly muricate; sepals 4, free, green; outer pair D-shaped, *c.* 1.2 mm long and 1.4 mm wide; inner pair ovate, *c.* 2.5 mm long and 2 mm wide, glabrous; petals 5, free, orbicular or obovoid, *c.* 8 mm long and 6 mm wide, green or greenish-yellow; disk oblate, yellow, with *c.* 26 free staminodes, diameter *c.* 3.5 mm, sunken directly below each staminode; staminodes *c.* 2 mm long; antherodes 1 per staminode, ± globose, bilobed, diameter *c.* 0.5 mm; ovary obovoid, *c.* 3 mm long and 3 mm wide, 2-locular, locules uniovulate; stigma domed, not rayed. **Fruiting pedicel:** not seen for Australian material, recorded as: at least as long as fruit, staminodes usually persistent at base, sepals absent at base; **fruit** (not seen for Australian material) a fleshy berry, globular or obovoid, 10–30 mm long, 10–30 mm wide, orange or reddish-orange; seeds 1 or 2, cylindrical, 8–20 mm long; aril fleshy, orange. *African mangosteen*, *lowveld mangosteen*, *imbe*. **Fig. 2H.**

***Additional selected specimens (from 54 examined)*: Senegal.** Ouassadou, Jan 1959, *Berhaut 4302* (P[1]). **Mali.** Bankoumana, Nov 2005, *Birnbaum 920* (P[1]); Tienfala (25 km E Bamako), Dec 1978 (P[1]). **Cameroon.** Southwest Province: Mt Kupe, Feb 1986, *Thomas & McLeod 5480* (P[1]). **Comoros.** Mayotte, Sohoa, May 1997, *Pascal 934* (P[1]); Itsamia, Nov 1999, *Labat 3223 & Yahaya, Dloubeiri & Mindhiri* (P[1]). **Kenya.** Sep 1957, *Verdcourt 1936* (P[1]). **Tanzania.** 40 km west of Lindi, Sep 1934, *Schlieben 5402* (P[1]); Zanzibar, Nov 1889, *Sacleux 886* (P[1]); Pwani Coast Region, Matumbi Hills, Oct 1997, *Phillipson 4960, Sitoni & Kibure* (P[1]). **Zimbabwe.** Urungwe District, Oct 1964, *Bingham 1370* (P[1]). **Mozambique.** Gaza, Nov 1970, *Correia 2015* (P[1]); Lugela-Mucuba, Namagoa, s.dat., *Faulkner Kew 77* (P[1]). **Australia. Queensland.** Cook District: Cooktown, Anzac Memorial Park, Sep 2008, *McKenna 267* (CNS); Helen St, Cooktown, May 2013, *Cooper 2218 & Cooper* (CNS); Trevethan Creek, Cooktown Development Road, May 1998, *Jago s.n. & Wannan* (CNS).

***Distribution and habitat*:** *Garcinia livingstonei* is a native of Africa with a widespread distribution, occurring on the mainland from West Africa (including Senegal, Mali, Nigeria and Cameroon) through to Somalia and East Africa (including Kenya and Tanzania) and south to Zimbabwe, Angola and South Africa; as well as the Comoros islands. In Australia it has been cultivated and a recent record (*Jago s.n. & Wannan* CNS) from Trevethan Creek near Cooktown indicates possible naturalization (**Map 1**).

***Phenology*:** Flowers from Australian material have been recorded in May and no fruiting records exist.

***Notes*:** Cultivated plants of *Garcinia livingstonei* in Cooktown, which had been poisoned, were sprouting vigorous suckers from the base of otherwise dead trees.

One tree at Cooktown (*Cooper 2218*) had both female and male flowers confirming that this species is monoecious.

***Etymology*:** The specific epithet is in honour of the explorer David Livingstone (1813–1873), who was amongst the first to collect this species.

4. Garcinia jensenii W.E.Cooper **sp. nov**. Similar to *Garcinia hunsteinii* Lauterb. but differs in the leaf apex (bluntly acute versus acuminate), secondary veins (7–10 pairs versus *c.* 50 pairs), and secondary vein angle (*c.* 45° versus *c.* 80°). **Typus:** Australia: Queensland. Cook District: about 3 km N of 3-ways, Iron Range National Park, 29 July 2013, *W.Cooper 2225, C.Zdenek, B.Venables & J.Pritchard* (holo: CNS [2 sheets + spirit], iso: 13 sheets to be distributed to A, BRI, CANB, FRI, K, KEP, KL, MEL, MO, NSW, NY, SING, US).

Garcinia riparia auct. non A.C.Sm.; Hyland *et al.* (2003, 2010); CHAH (2007).

Garcinia sp. (Claudie River L.J.Brass 19658) in part; Jessup (2007: 54, 2010: 44).

***Illustrations*:** Christophel & Hyland (1993: 81) as *G. riparia* vel aff.; Hyland *et al.* (2003, 2010), CHAH (2007) as *G. riparia;* Zodiac Publications (undated), as *Garcinia* sp. Claudie River.

Tree to 15 m, dioecious; exudate white or colourless; dbh to 150 mm; bark slightly flakey with fine vertical fissures, lenticels horizontal and more prevalent on younger trees; branchlets square, young twigs narrowly 4-winged. **Leaves** discolorous, coriaceous, glabrous; petioles 5–7 mm long, channelled, ligulate; lamina narrowly to broadly elliptic, ovate-elliptic or obovate, 52–160 mm long, 20–72 mm wide; base cuneate, attenuate or decurrent; apex acute, retuse-acute or rounded-acute; margin entire; venation brochidodromous, primary vein on upperside flush or slightly raised, distinctly raised on underside; secondary veins 7–10 pairs, slightly raised on both surfaces, angle of divergence with primary vein *c.* 45°, forming intramarginal loops 0.4–1.4 mm from margin; exudate-containing canals numerous and conspicuous on the underside as unbranched lines ± parallel to each other and running at angles between primary vein and margin. **Male inflorescences** axillary, a fascicle or raceme, 5–many-flowered, rachis up to 3.5 mm long; bracts at pedicel bases broadly ovate, apex acute, base truncate, convex, *c.* 1.6 mm long and 1 mm wide, glabrous; bracteoles present or absent, part way along pedicels, solitary or paired, broadly ovate, convex, *c.* 1 mm long and 1 mm wide, glabrous. **Male flowers:** fragrance not recorded, diameter 7–8 mm; pedicels 4.5–12 mm long; sepals 4, 2-whorled, colour not recorded but probably white or green white like females, glabrous; outer pair joined, D-shaped, convex, may be keeled, *c.* 1.6 mm long and 1.8 mm wide; inner pair free, petal-like, orbicular, convex, *c.* 4 mm long and 3 mm wide; petals 4, free, imbricate, orbicular, convex, *c.* 4 mm long and 3–4 mm wide, membranous, colour not recorded but probably white like females, glabrous; androecium 4-phalangiate, glabrous; phalanges antepetalous, strap-shaped, slightly ribbed, erect or distally inflexed, *c.* 3.2 mm long and 2–3 mm wide, apex divided into 2–7 short filaments; anthers 15–30 per phalange, completely enveloping phalange apex, D-shaped, circular or irregular, margin lobed, erect or introrse, diameter 0.5–6 mm; pistillode fungiform, *c.* 3 mm long and 2 mm wide at apex, apex colour not recorded but probably yellow like females. **Female inflorescences** terminal or axillary, supra-axillary or ramiflorous, a solitary flower, fascicle or condensed raceme, 3–9-flowered; peduncles 1.2–2 mm long; bracteoles triangular, keeled, *c.* 1 mm long and 1 mm wide, entire, persistent. **Female flowers:** fragrance not detected, diameter 4.5–6.5 mm; pedicels 3.5–4.5 mm long; sepals 4, 2-whorled, D-shaped, convex, white or palest green, glabrous; outer pair joined, *c.* 1 mm long and 2 mm wide, coriaceous; inner pair free, petal-like, orbicular, convex, 1.2–2 mm long and 2–3 mm wide, membranous; petals 4, free, imbricate, orbicular, convex, *c.* 2 mm long, 2–3 mm wide, margin thin, white, glabrous; gynoecium fungiform, unlobed, glabrous; ovary obovoid and laterally compressed, *c.* 1.2 mm long and 1.8 mm wide, 2-locular, uniovulate; stigma disc-like, entire, diameter *c.* 2.5 mm, yellow, not viscous. **Fruiting pedicel** *c.* 5 mm long; 2 joined sepals persistent at base; **fruit** a fleshy berry, globose or ellipsoid-globose, 12.5–15.5 mm long, 11–16 mm wide, pink or reddish; stigma at apex, diameter 3–3.8 mm; seeds 1 or 2, *c.* 10 mm long and 5 mm wide; testa and aril not recorded. **Fig. 1D, 2C.**

***Additional selected specimens (from 23 examined)*: Australia. Queensland.** Cook District: Widul Island, 4 km west of Mabuyang Island Airfield, 73 km NNW of Horn Island Airfield, Apr 2009, *Fell 10037* (CNS); Ulu (Saddle Islet), 62 km NE of Horn Island Airfield, Torres Strait, Feb 2012, *Fell 10712* (CNS); Eet Hill Track, Moa Island, Torres Strait, May 1987, *Budworth 1185* (BRI); *c.* 2 km N of St Paul's community, Moa Island, 46 km NNE of Horn Island Airfield, Torres Strait, Nov 2007, *Fell 8955* (CNS); Mew River, Muddy Bay, Cape York, Jun 1994, *Forster PIF15300 & Tucker* (BRI); Lake Boronto – Newcastle Bay, Cape York Peninsula, Sep 1974, *Tracey 14349* (BRI); Between Lockerbie & Somerset, Feb 1980, *Hyland RFK3984* (CNS); Lockerbie Scrub, Sep 1974, *Tracey 14306* (BRI); 5.5 km NE of Moreton, Jun 1994, *Fell 4457 & Buck* (BRI); Olive River, N bank, Sep 1974, *Tracey14373* (BRI); Nelson Creek, Aug 2011, *Cooper 2145, Venables & Murphy* (CNS); Iron Range NP, southside of Pascoe River, Sep 2004, *Sankowsky 2517 & Sankowsky* (BRI); about 3 km N of 3-ways, Iron Range NP, Dec 2012, *Cooper 2194, Jensen & Kemp* (CNS); Iron Range, Jul 1923, *Brass 19658* (BRI); about 2.8 km

N of 3-ways Iron Range NP, Jun 2013, *Cooper 2219, Cooper & Venables* (CNS); Chester River, Jun 1977, *Hyland RFK3555* (CNS); TR 14, Leo Creek Mine area, McIlwraith Range, Jun 1992, *Forster PIF10160, Tucker & Kenning* (BRI); McIlwraith Range, E foothills, Rocky River, Oct 1969, *Webb 9345 & Tracey* (BRI).

***Distribution and habitat*:** *Garcinia jensenii* grows on red soils derived from a mixture of basic igneous rocks and ferrugineous sandstone. It is as an understory tree in rainforest (semideciduous notophyll/ mesophyll vine forest) from the Torres Strait islands and down the eastern side of Cape York Peninsula to the McIlwraith Range at altitudes between sea level and 500 m (**Map 2**).

Garcinia jensenii occurs in rainforest dominated by *Archidendron hirsutum* I.C.Nielsen, *Buchanania arborescens* (Blume) Blume, *Calamus caryotoides* A.Cunn. ex Mart., *Dillenia alata* (R.Br. ex DC.) Martelli, *Euonymus australiana* F.Muell., *Hydriastele costata* F.M.Bailey, *Maranthes corymbosa* Blume, *Planchonella xylocarpa* C.T.White, *Ptychosperma elegans* (R.Br.) Blume, *Syzygium bamagense* B.Hyland & *Syzygium pseudofastigiatum* B.Hyland.

***Phenology*:** Flowers have been recorded in July and August; fruits have been recorded in December and February.

***Affinities*:** Within Australia, *Garcinia jensenii* is most similar to *G. zichii* W.E.Cooper. Both species have similarly shaped leaves and exudate canal pattern, a 2-locular ovary and 1 or 2-seeded fruit. *G. jensenii* has leaves with 7–10 pairs of secondary veins, flowers with white petals and fruit that are globose or ellipsoid-globose. *G. zichii* has leaves with 12–18 pairs of secondary veins, flowers with green or yellow petals and fruit that are distinctly ellipsoid.

***Notes*:** In Queensland, *Garcinia jensenii* has been confused with *G. riparia* that is considered to be endemic to New Guinea; however, the two species are significantly different morphologically. *G. jensenii* has white or colourless exudate, flowers pedicellate, ovary 1 or 2-locular, fruit not ribbed and 1 or 2-seeded. *G. riparia* has yellow exudate, flowers sessile with a 7–10-locular ovary, fruit ribbed and many-seeded.

***Etymology*:** The specific epithet honours botanist Rigel Jensen (1959–) acknowledging his contribution to botany in Australian and New Guinea, as well as his enthusiastic assistance with all of my botanical projects.

5. Garcinia zichii W.E.Cooper **sp. nov.** Similar to *Garcinia hunsteinii* but differs in the leaf apex (acute versus acuminate), lateral veins (7–10 pairs versus *c.* 50 pairs), lateral vein angle (*c.* 45° versus *c.* 80°) and the fruit shape (ellipsoid versus globose). **Typus:** Australia: Queensland. North Kennedy District: Tully Falls National Park, 2.2 km along Tully Falls Road from Charmillan Creek bridge, 8 November 2011, *A. Ford 5908 & M. Torello-Raventos* (holo: CNS [2 sheets + spirit], iso: 10 sheets to be distributed to BRI, CANB, K, KL, L, MEL, MO, NSW, SING).

Garcinia sp. aff. *G. hunsteinii*; Hyland (1982); http://www.anbg.gov.au/cgi-bin/apni Accessed January 2013.

Garcinia sp. (Davies Creek JGT 14745); Hyland *et al.* (2003).

Garcinia sp. (Davies Creek); Cooper & Cooper (2004: 124).

Garcinia sp. (Davies Creek J.G.Tracey 14745); Jessup (2007: 49, 2010: 44).

Garcinia sp. Davies Creek (J.G.Tracey 14745); CHAH (2007); Hyland *et al.* (2010).

Garcinia sp. (=AFO/1268); http://www.anbg.gov.au/cgi-bin/apni Accessed January 2013.

***Illustrations*:** Christophel & Hyland (1993: 81) as *G.* sp. aff. *G. hunsteinii*; Hyland *et al.* (2003) as *G.* sp. (Davies Creek JGT 14745); Cooper & Cooper (2004: 124) as *G.* sp. (Davies Creek); Hyland *et al.* (2010), as *G.* sp. Davies Creek (J.G.Tracey 14745).

Small tree or canopy tree to 30 m, dioecious; exudate colourless, white or slightly milky, meager; dbh to 20 cm, may have small buttresses; bark rough, fissured, slightly flaky, lenticels pale orange; branchlets square, deeply grooved between last 2 pairs of leaves, becoming terete. **Leaves** discolorous,

coriaceous, glabrous; petioles 5–10 mm long, channelled, ligulate; lamina elliptical or rarely obovate, 35–110 mm long, 15–35 mm wide; base attenuate, cuneate or decurrent; apex bluntly acute; margin flat or may be recurved; venation brochidodromous, primary vein distinctly raised on upperside, slightly raised near base on underside and flush or slightly depressed towards apex; secondary veins obscure, 12–18 pairs, flush on both sides, angle of divergence with primary vein *c.* 60°, forming intramarginal loops *c.* 0.5 mm from margin; exudate-containing canals numerous and conspicuous on the underside as unbranched lines ± parallel to each other and running at angles between primary vein and margin. **Male inflorescences** axillary or rarely terminal, an umbel or rarely a cyme, 2–11-flowered (mostly 3–5-flowered), peduncles 0.8–2.5 mm long; bracts at peduncle bases and bracteoles at pedicel bases similar, triangular or broadly rhomboid, convex, keeled, 0.8–2.6 mm long, muricate, apex serrate with 3–7 teeth, caducous. **Male flowers:** not fragrant, diameter 7.5–8.5 mm, glabrous; pedicels 3.5–5 mm long; sepals 4, outer pair joined, inner pair free, imbricate, D-shaped, convex but not keeled, 2–4 mm long, 2–4 mm wide, coriaceous-membranous, yellow or green, glabrous, margin thin; petals 4, free, orbicular, convex, not keeled, becoming reflexed but remaining incurved at apex, 3–4.5 mm long, 3–4.5 mm wide, membranous, green; androecium 4-phalangiate; phalanges antepetalous, strap-shaped, ribbed, erect and becoming slightly reflexed, 1–4 mm long, 1–2 mm wide, apex undivided or divided into two short arms; anthers *c.* 20 per phalange, completely enveloping phalange apex, oblong, 0.8–1 mm long, *c.* 0.3 mm wide; pistillode fungiform, 2–2.5 mm long, 2–2.8 mm wide at apex, apex dark orange-red or reddish-brown and quickly becoming viscous once flowers are open. **Female inflorescences** axillary, an umbel, 3–5-flowered, peduncles 1–2 mm long; bracteoles triangular, *c.* 1.2 mm long and 1 mm wide, muricate, margin 3–5-toothed, caducous. **Female flowers:** occasionally fragrant, diameter 6–8 mm; pedicels 2–5 mm long; sepals 4, D-shaped or deltoid, convex, not keeled or slightly keeled, coriaceous-membranous, yellow or green, margin thin; outer pair joined, *c.* 2 mm long, 2–3 mm wide; inner pair free, 2–4 mm long, 2.5–4 mm wide; petals 4, free, imbricate, becoming reflexed, orbicular, convex, not keeled, 2.2–4.2 mm long, 2.8–4.2 mm wide, coriaceous-membranous, yellow or green, margin thin; gynoecium fungiform, glabrous; ovary ellipsoid, 0.6–1.5 mm long, 4–7 mm wide, 2-locular, uniovulate; stigma disc-like, entire, diameter 4–5 mm, yellow, orange, rusty red or brownish-red, quickly becomes viscous once flowers are open. **Fruiting pedicel** 2.5–5 mm long; sepals absent from base; **fruit** a fleshy berry, ellipsoid, 25–37 mm long, 10–18 mm wide, red to dark red or blackish; stigma at apex, diameter 4–6 mm; seeds one or two, surface slightly undulating, 22–32 mm long, 11–12 mm wide; testa brown; aril meagre, clear, gelatinous. *baconwood*, *marblewood*. **Fig. 1G & H.**

***Additional selected specimens (from 118 examined)*: Australia. Queensland.** Cook District: Cedar Bay NP, western slopes of Mt Finnigan, Oct 1999, *Forster PIF25016 & Booth* (BRI); Mt Hemmant just N of Noah Creek in Cape Tribulation area, Jul 1973, *Webb 11967 & Tracey* (BRI); Mt Windsor NP, Nov 2008, *Forster PIF34675, Jensen & McDonald* (BRI); Mt Misery, Jun 1992, *Forster PIF10759, Sankowsky & Tucker* (BRI); Pinnacle Rock Track, 4.5 km W of Karnak, Jun 1992, *Forster PIF10700, Sankowsky & Tucker* (BRI); TR 66, Mt Lewis, Jun 1997, *Forster PIF21239, Jensen & Tucker* (BRI); Mt Lewis Road, Aug 1957, *Smith 10094* (CANB); Davies Creek, SF 607, Aug/Sep 1971, *Tracey 14745* (BRI); SFR 607, Emerald LA, Aug 1982, *Gray 2701* (CNS); Mt Haig, Oct 2012, *Cooper 2147 & Ford* (CNS); Mt Haig, CSIRO plot E27, Oct 2012, *Cooper 2148 & Ford* (CNS); Lake Morris Road at start of track to tower 20, Sep 2012, *Dowe 1159* (CNS); Copperlode Dam, Cairns, Oct 1970, *Gittins 2196* (NSW); Palmerston Ridge Track, Wooroonooran NP, Feb 1995, *Hunter 1109* (BRI); Breeden property, Hughes Road, Topaz, Aug 1997, *Cooper 1152 & Cooper* (CNS); Track to Phoenix Battery, Towalla, Jul 1997, *Cooper 1132 & Cooper* (CNS); Elinjaa LA, Oct 1974, *Irvine 961* (CNS); Tully Falls NP, 2.2 km along Tully Falls road from Charmillan Creek bridge, Nov 2011, *Ford 5909 & Torello-Raventos* (CNS); SFR 344, Douglas Creek, 0.7 km along Carron Creek Road from Kirrama Road, Jun 2002, *Ford 3510 & Holmes* (CNS).

***Distribution and habitat*:** *Garcinia zichii* is endemic to the Wet Tropics bioregion of north-east Queensland from Mt Finnigan to the Kirrama Range (**Map 2**) at altitudes between 150–1300 m. It occurs in rainforest (evergreen simple to complex notophyll/

mesophyll vine forest) on soils derived from granite and rhyolite.

Garcinia zichii grows often in association with *Beilschmiedia oligandra* L.S.Sm., *Cryptocarya angulata* C.T.White, *Elaeocarpus elliffii* B.Hyland & Coode, *Flindersia pimenteliana* F.Muell., *Planchonella euphlebia* (F.Muell.) W.D.Francis, *Syzygium endophloium* B.Hyland & *S. wesa* B.Hyland.

***Phenology*:** Flowers have been recorded in October and November; fruits have been recorded from June to November.

***Affinities*:** Within Australia, *Garcinia zichii* is most similar to *G. jensenii*. Both species have similarly shaped leaves and exudate canal pattern, a 2-locular ovary and 1 or 2-seeded fruit. *G. zichii* has leaves with 12–18 pairs of secondary veins, flowers with green or yellow petals and fruit that are distinctly ellipsoid. *G. jensenii* has leaves with 7–10 pairs of secondary veins, flowers with white petals and fruit that are globose or ellipsoid-globose. *G. zichii* is also similar to *G. hunsteinii* Lauterb. from New Guinea. *G. zichii* has colourless, slightly milky or white latex, leaf apex bluntly acute and fruit much longer than wide, whereas *G. hunsteinii* has white or yellow latex, leaf apex acuminate and globose fruit.

***Notes*:** There is one specimen (*Cooper 1152*) as well as an observation by Tim Hawkes *pers. comm.*, of fruit dehiscing, which was presumably caused by recent abundant rainfall. This phenomenon is well documented within horticulture for other plant groups, occurring after superfluous moisture is applied to orchard plantings. The abundant water causes osmotic absorption through the epicarp and the disintegration of the cuticle (Opara *et al.* 1997: 227).

The exudate-containing canals within the leaves (a useful distinguishing character in Australian *Garcinia*) of this species are indistinguishable from *G. jensenii* (**Fig. 2C**).

***Etymology*:** The specific epithet honours Frank Zich (1968–), a most competent and obliging curator of the collection at the Australian Tropical Herbarium (CNS).

6. Garcinia leggeae W.E.Cooper **sp. nov.** Similar to *Garcinia riparia* but differs by flower diameter (5 mm versus 15 mm), stamen number (5–9 versus 40–50), fruit shape (ovoid versus obovoid, oblate or patelliform), fruit size (20–27 mm long and 29–45 wide versus *c.* 70 mm long and *c.* 50 mm wide), sepal size on fruit (*c.* 1.5 mm long versus *c.* 5 mm in *G. riparia*). **Typus:** Australia: Queensland. Cook District: Gordon Creek, Iron Range National Park, 5 December 2012. *W.Cooper 2187, R.Jensen & J.Kemp* (holo: CNS [2 sheets + spirit], iso: 7 sheets to be distributed to BRI, CANB, K, KEP, L, MO, SING).

Garcinia sp. (Claudie River LJB 19658) in part; Hyland *et al.* (2003).

Garcinia sp. (Claudie River); Cooper & Cooper (2004: 123).

Garcinia riparia auct. non A.C.Sm.; Cooper & Cooper (2004: 123).

Garcinia sp. (Claudie River L.J.Brass 19658) in part; Jessup (2007: 54, 2010: 44).

Garcinia sp. Claudie River (L.J.Brass 19658) in part; CHAH (2007); Hyland *et al.* (2010).

***Illustrations*:** Christophel & Hyland (1993: 81) as *G. riparia* vel aff.; Cooper & Cooper (1994: 146–147) as *G. riparia vel. aff.*; Hyland *et al.* (2003) as *G.* sp. (Claudie River LJB 19658); Cooper & Cooper (2004: 123) as *G.* sp. (Claudie River) & as *G. riparia*.

Shrub or small tree to 6 m, dioecious; exudate yellow; dbh to 100 mm, often multi-stemmed; bark grey or greyish-brown, fissured and flakey, lenticels numerous; branchlets square, glabrous. **Leaves** discolorous, almost membranous, shiny on upperside and less so on underside, glabrous; petioles 5–8 mm long, channelled, not ligulate; lamina elliptical, 30–145 mm long, 25–57 mm wide, base cuneate; apex acuminate or caudate, rarely acute or obtuse; margin narrowly recurved; venation brochidodromous, primary vein flush on upperside and raised on underside; secondary veins 12–16 pairs, slightly raised on both surfaces, becoming puckered in dry

specimens, angle of divergence from primary vein *c.* 45º, intramarginal vein 0.6–1.2 mm from margin; exudate-containing canals numerous, continuous parallel or intertwined lines running at angles between ± parallel to primary vein and diverging up to *c.* 45º. **Male inflorescences** axillary or ramiflorous, a fascicle seated on a pulvinus, 1–3-flowered; bracteoles persistent, triangular, *c.* 0.7 mm long and 0.8 mm wide, base truncated, apex acute, glabrous, margin entire. **Male flowers:** fragrant, diameter 5–6.5 mm, glabrous, sessile; sepals 4, 2-whorled, free, ovate, convex, entire, *c.* 1.5 mm long and 1 mm wide, membranous, green or yellowish, glabrous, margin thin; petals 4 (rarely 5), free, explanate, oblong-elliptic, sometimes slightly convex, 2.5–3 mm long, *c.* 1.5 mm wide, membranous, cream or yellow, margin entire or minutely ciliate; androecium a fleshy receptacle not adnate to petals, *c.* 0.5 mm long; anthers 5–9, sessile or almost sessile, erect or extrorse, quadrate, *c.* 0.4 mm long and 0.4 mm wide, bithecate; pistillode absent. **Female inflorescences** axillary or ramiflorus, a solitary flower, sessile; bracteoles persistent, triangular, convex, *c.* 0.8 mm long and 0.8 mm wide, base truncated, apex acute, glabrous, margin entire. **Female flowers:** fragrant, diameter *c.* 5 mm, sessile; sepals 4, 2-whorled, free, ovate, convex, 2–3 mm long, 1.5–2 mm wide, membranous, green or yellowish, glabrous, margin thin, entire; petals 4, free, spreading widely, oblong-elliptic, sometimes slightly convex, *c.* 3 mm long and 1.5 mm wide, membranous, cream or yellow, glabrous, margin entire and thin; staminodal phalanges 4, adnate to petals, filament-like with a globose apex, distally inflexed, *c.* 1.4 mm long; antherodes 1 per phalange, *c.* 0.8 mm long; ovary urceolate, *c.* 2.5 mm long and 1.5 mm wide, sessile, 6–13-locular, uniovulate; stigma sessile, diameter *c.* 1.5 mm. **Fruiting pedicel** 0.7–1 mm long, sepals persistent at base *c.* 1.5 mm long, **fruit** a fleshy berry, ovoid (oblate, patelliform or asymmetrical when some ovules infertile), 20–27 mm long, 29–45 mm wide, pink-red to dark red, 6–13 septum lines, 6–13 segments; seeds 6–13, hairy, *c.* 11 mm long and 7–8.5 mm wide (not including hairs); testa brown; aril fleshy, translucent whitish or pinkish. **Figs. 1E, 2F.**

***Additional selected specimens (from 22 examined)*: Queensland.** Cook District: Claudie River, Nov 1977, *Hyland RFK3623* (CNS); *ditto*, Jan 1982, *Hyland 11515* (CNS); *ditto*, Dec 1982, *Hyland 12412* (CNS); *ditto*, Dec 1982, *Hyland 12413* (CNS); West Claudie River, Iron Range, Aug 1997, *Jensen 874* (CNS); Iron Range, Sep 1962, *Volck AFO2600* (CNS); Iron Range NP, CSIRO EP/42, Sep 2008, *Ford 5422, Metcalfe, Murphy & Bradford* (CNS); Claudie River EP/42, July 1978, *Unwin 625* (CNS); Claudie River, Iron Range, May 1992, *Cooper 279 & Cooper* (CNS); Claudie River area, Oct 1968, *Webb 8335 & Tracey* (BRI); Claudie River, Iron Range NP, Dec 2012, *Cooper 2168*, *Jensen & Kemp* (CNS); Gordon Creek, Iron Range NP, Dec 2012, *Cooper 2171*, *2175, 2177, 2186, 2188, Jensen & Kemp* (CNS); *ditto*, Jun 2014, *Cooper 2220 & Cooper* (CNS); Gordon Creek, 10 km ENE of Mt Tozer, Iron Range NP, May 1992, *Fell 2543* (BRI).

***Distribution and habitat*:** *Garcinia leggeae* is endemic to rainforest (evergreen mesophyll vine forest) in the Iron Range area, mostly on the Claudie River and Gordon Creek floodplains but occasionally on hillslopes to an altitude of 75 m (**Map 3**).

Garcinia leggeae grows as an understory shrub or small tree on alluvial soils derived from basalt, frequently under a canopy of *Blepharocarya involucrigera* F.Muell., *Calamus australis* Mart., *Garcinia dulcis*, *G. warrenii*, *Lasjia claudiensis* C.L.Gross & B.Hyland, *Myristica insipida* R.Br., *Nauclea orientalis* (L.) L., *Pandanus zea* H.St.John, *Syzygium bamagense* B.Hyland & *Tetrameles nudiflora* R.Br.

***Phenology*:** Flowers have been recorded in June and December; fruits have been recorded in May, August and September.

***Affinities*:** *Garcinia leggeae* is similar to *G. riparia* from New Guinea. Compared with *G. riparia*, *G. leggeae* is a more diminutive plant, having much smaller flowers (5 mm versus 15 mm) with fewer stamens (5–9 versus 40–50), smaller fruit (20–27 mm long and 29–45 wide versus *c.* 70 mm long and *c.* 50 mm wide) and smaller sepals on ripe fruit (*c.* 1.5 mm long versus *c.* 5 mm).

***Notes*:** Plants are frequently multi-stemmed, presumably caused by the forces of floodwater and floating debris during the wet season.

Some leaves on most herbarium collections, and all plants in the field seen by the author, are marked with black spots (diameter *c.* 5 mm), which appear to be caused by insects rather than fungi.

***Etymology*:** The specific epithet honours ornithologist and ecologist Sarah Legge (1969–) who collected this species as well as many other valuable specimens for illustration in the fruit book (Cooper & Cooper 2004), while working in the Iron Range area.

7. Garcinia mestonii F.M.Bailey, *Report on New Plants, Preliminary to General Report on Botanical Results on Meston's Expedition to the Bellenden-Ker Range* 2 (1889), as 'mestoni'. **Type:** Australia: Queensland. Cook District: Bellenden-Ker Range at an altitude of 2000 feet, [June 1889], [*A.Meston & D.Whelan s.n.*] (holo: BRI [AQ340247][1]).

***Illustrations*:** Christophel & Hyland (1993: 81); Cooper & Cooper (2004: 123), Hyland *et al.* (2010).

Shrub or small tree to 6 m, dioecious (rarely monoecious); exudate yellow, meagre; bark nondescript with irregular-shaped lenticels; branchlets square when young, becoming terete. **Leaves** discolorous, coriaceous, glabrous; petioles 6–11 mm long, channelled, not ligulate; lamina elliptic, ovate, lanceolate, obovate, oblanceolate, 35–80 mm long, 12–34 mm wide; base attenuate, cuneate or oblique; apex caudate or acuminate; margin may be recurved in dry specimens; venation brochidodromous, primary vein ± flush on upperside and raised on underside; secondary veins 10 pairs, angle *c.* 70° to primary vein, forming loops *c.* 1 mm from margin; exudate-containing canals numerous as short streaks, dashes and dots (more conspicuous on upperside), running at angles between 45° and parallel to primary vein or margin. **Male inflorescences** axillary, terminal or ramiflorous, a 2–5-flowered umbel or fascicle; bracts oblong, convex, 1.5–5.5 mm long, 0.5–0.8 mm wide, glabrous, apex obtuse, base truncate, caducous; bracteoles triangular, *c.* 0.8 mm long and 0.6 mm wide, caducous; peduncles absent or up to 4 mm long. **Male flowers:** not fragrant, diameter *c.* 4 mm; pedicels 1.5–2.5 mm long; sepals 4, 2-whorled, outer pair joined, D-shaped, cupular, *c.* 4 mm long and 4.5 mm wide, green, glabrous, margin thin; petals 4, orbicular, cupular with apex recurved, *c.* 4.8 mm long and 4.8 mm wide, membranous, green or cream, glabrous, margin thin; androecium a fleshy receptacle not adnate to petals, *c.* 2.5 mm long and 3.2 mm wide; anthers *c.* 16, triangular, sessile or almost sessile, 0.6–1 mm long, 0.6–1 mm wide at base, bithecate; pistillode absent. **Female inflorescences** axillary or terminal, solitary flowers or 2–3-flowered umbels or fascicles; bracts 4-whorled, oblong, 1.5–3.2 mm long, *c.* 1 mm wide, caducous; bracteoles triangular, *c.* 1 mm long and 0.6 mm wide; peduncle *c.* 1 mm long. **Female flowers:** not fragrant, pedicels *c.* 2.5 mm long, diameter 6–7.5 mm; sepals 4, 2-whorled, outer pair joined, inner pair free, D-shaped, cupular, 3.8–4.4 mm long, 4.3–5.5 mm wide, membranous, green or cream, glabrous; petals 4, free, orbicular, cupular with apex recurved, *c.* 5 mm long and 4 mm wide; staminodal phalanges adnate to petals, narrowly or broadly triangular, apically 2 or 3-branched, distally inflexed, *c.* 2 mm long, antherodes 2 per branch; ovary oblate, 2.2–2.8 mm long, 4–4.5 mm wide, sessile, 3–9-locular, uniovulate; style *c.* 0.5 mm long, stigma diameter *c.* 2.5 mm, 3–9-rayed. **Fruiting pedicel** 1–3 mm long; 4 sepals persistent at base; **fruit** a fleshy berry, depressed globular, 31–50 mm long, 40–60 mm wide, cream or greenish-cream; stigma 3–9-rayed, diameter 3.5–4 mm; seeds 13–25 mm long, *c.*10 mm wide, testa brown; aril fleshy, cream. *Meston's mangosteen.* **Fig. 1C & F, 2D.**

***Additional selected specimens (from 26 examined)*: Australia. Queensland.** Cook District: Little Cooper Creek, Cow Bay, Cape Tribulation area, Oct 1994, *Small s.n.* (CNS [QRS104526]); Behana Creek, S of Gordonvale, Jul 2005, *Halford Q8446 & Jensen* (BRI); Divide between Babinda Creek and East Mulgrave, May 2002, *Jago 6211* (CNS); Mt Harold, Aug 1985, *Irvine 2322, 2323* (BRI, CNS); Goldsborough Road, Mulgrave River Valley, Jul 1992, *Tucker s.n.* (CNS [QRS105577]); Goldsborough Road, Jul 1992, *Sankowsky 1332* (CNS); East Mulgrave River, Nov 1995, *Jensen 483* (CNS); Ridgeline NW of airplane wreck, Bellenden Ker, Jun 1995, *Hunter 5308* (BRI); Mt Bellenden Ker, *c.* 7/8 mile SE of centre peak, Jun 1969, *Smith 14691* (BRI); Harvey Creek, N of Bellenden Ker, Dec 1998, *Forster PIF24028* (CNS); Harvey Creek, Dec 2012, *Cooper 2203, 2204 &*

Jensen (CNS); Cultivated at Tolga, ex Harvey Creek, Dec 2003, *Sankowsky 2326 & Sankowsky* (BRI); Sankowsky's garden, Tolga [ex Harvey Creek], Jan 2013, *Cooper 2209, Sankowsky & Jensen* (CNS); NPR 226, Parish of Bellenden Ker, Dec 1983, *Hyland 25062 RFK* (BRI, CNS); Ridgetop S of Tower 6, Bellenden Ker, Jun 1995, *Hunter 5292* (BRI); E slopes of Bellenden Ker near Station 3 on the Bellenden Ker Cable Car Track, Jan 1981, *Irvine 2056* (BRI, CNS); Bellenden Ker, *s.dat.*, *Meston 1* (BRI [AQ166293]); Bellenden Ker Range, Mar 1922, *White s.n.* (BRI [AQ166291]); Bellenden Ker, below summit, Jun 1949, *Smith 4236* (BRI); Wooroonooran NP, headwaters of East Mulgrave River, 5 km W of Bellenden Ker township, Nov 2000, *Forster PIF26412, Booth & Jensen* (BRI).

***Distribution and habitat*:** *Garcinia mestonii* is endemic to the Wet Tropics bioregion of north-east Queensland between Cape Tribulation and the Mt Bellenden Ker Range (**Map 3**). It occurs in rainforest (evergreen, simple/complex notophyll/mesophyll vine forest) on granitic and metamorphic soils at altitudes between 30 and 1340 m.

***Phenology*:** Flowers have been recorded in December and January; fruit has been recorded from August to February.

***Typification*:** The type collection at BRI has minimal original labelling attached to the sheet, apart from a tattered scrap of paper with the number 18 and the words 'Meston's Apple'. No specific collectors or date of collection are given; although a copy of the protologue is attached. In the protologue Bailey (1889) noted that it was collected by Messrs. Meston and Whelan on the first ascent of Bellenden Ker. As noted by Dowe & Broughton (2007) this was in June 1889.

Archibald Meston is well known as the leader and organiser on the 1899 and 1904 Bellenden Ker expeditions, but was also a significant collector of plant specimens, particularly on the latter expedition when F.M.Bailey was absent (Dowe & Broughton 2007, 2008). The co-collector of the type of *Garcinia mestonii* was Daniel Whelan, a Sergeant in the infamous [Queensland] Native Mounted Police (Richards 2008) and who led the force of troopers allocated as protection on the 1889 expedition. Whelan was honoured by Bailey with the Proteaceous tree *Lasjia whelanii* (originally as *Helicia whelanii* F.M.Bailey) and the fern *Blechnum whelanii* F.M.Bailey. The 'Whelanian Pools Camp' on Bellenden Ker was also named for him (Dowe & Broughton 2007).

***Notes*:** *Garcinia mestonii* has been recorded as dioecious in the field; however, one plant cultivated by G & N Sankowsky at Tolga is distinctly monoecious with about 50% of flowers being male and 50% female. Individual branches on this tree appear to bear flowers of one sex only.

***Etymology*:** The specific epithet honours Archibald Meston (1851–1924), a botanical collector, journalist, civil servant, explorer and member for Rosewood in the Queensland Legislative Assembly from 1878–1882.

8. *Garcinia mangostana L., *Sp. Pl.* 443 (1753). **Type:** 'Mangostan' in L.Garcin, *Philos. Trans.* 38: t. 1 (1734); *fide* Hammel (1993: 28).

***Illustrations*:** Fleming (*c.* 1795–1805); Hooker (1855: t. 4847); van Nooten (1863); Marsden (2005: plate 3); Nazre (2006: 41, 45, 49, 52, 54, 57, 63, 181); Te-chato (2007: 248, 249, 250).

Tree to 20 m, agamospermous; exudate yellow; bark fissured and flaky; branchlets ± terete with some ribbing, glabrous. **Leaves** discolorous, coriaceous, glabrous, drying reddish-brown; petioles 10–30 mm long, not channelled on fresh specimens and slightly channelled on dried specimens, ligulate; lamina elliptic, broadly elliptic, ovate or oblanceolate, 100–250 mm long, 45–105 mm wide, base cuneate or obtuse; apex acute, shortly acuminate or obtuse; margin narrowly recurved; venation brochidodromous, primary vein distinctly raised on both sides; secondary veins 15–17 pairs, prominent, angle of divergence 50–70° from primary vein; 2 intramarginal veins, outermost 0.5–2 mm from margin, innermost 3–7 mm from margin; exudate-containing canals on underside as numerous branched lines running at angles between parallel to primary vein and margin, on upperside as numerous branched lines mostly running parallel to secondary venation. **Male flowers** unknown. **Female inflorescences** terminal, a solitary flower, pairs or rarely in 3's. **Female flowers:**

diameter 25–60 mm; pedicels 1.5–20 mm long; sepals, 4, 2-whorled, *c.* 20 m long, green, cream, yellowish, pinkish or reddish, cupular, coriaceous; petals 4, free, erect to spreading, broadly obovate or broadly orbicular, *c.* 25 mm long, cream, pink or reddish, glabrous, thickly fleshy; staminodes up to 20 shorter than ovary, adnate to petals, free, filament-like, *c.* 5 mm long, caducous; antherodes 1 per filament; ovary broadly ovoid or ellipsoid or globose, 12–16 mm, sessile, 4–8-locular, locules uniovulate; stigma mass sessile, domed, diameter 8–12 mm, 4–8-lobed. **Fruiting pedicel** with 4 green to reddish sepals persistent at base; **fruit** a dry berry with a thick corky-leathery pericarp *c.* 9 mm wide, globose or depressed globose, diameter 35–70 mm, purple to blackish, glabrous; sepals persistent; stigma persistent, 4–8-rayed; seeds 4–8, 15–25 mm, testa brown; aril thickly fleshy and white. *mangosteen, Queen of fruit.*

***Additional selected specimens (from 5 examined)*: Queensland.** Cook District: Cultivated, Stanton property, Intake Road, Redlynch, Cairns, Jul 2013, *Cooper 2222* (CNS); North Johnstone River, off the Cooroo Lands Road, W of Innisfail, Jul 2007, *Bean 26749* (BRI); Dunk Island, Aug 1963, *Scanlan AFO 2812* (CNS); Dunk Island, Aug 1964, *Scanlan AFO 3490* (CNS); Tully, Sep 1941, *Shearer s.n.* (CNS).

***Distribution and habitat*:** *Garcinia mangostana* is unknown in the wild but is likely to have originated on Peninsula Malaysia (Richards 1990b). In Australia it is cultivated in the tropical lowlands of Queensland, and a recent collection (*Bean 26749*), in the Innisfail area, confirms naturalisation within Queensland rainforest. Three old collections from Dunk Island and Tully also indicate possible naturalisation (**Map 3**).

***Phenology*:** Flowers and fruit have not been collected from naturalised plants; however, Peter Stanton and Allen Sheather have cultivated plants in the Cairns and Daintree areas and record flowers from September to March; fruit December to July.

***Notes*:** *Garcinia mangostana* is thought to be a hybrid of multiple origins (Richards 1990b). Within tropical Asia, Mangosteens have been widely cultivated over hundreds of years for their delicious arils and are referred to as the Queen of Fruit. Several authors including Richards (1990a), suggest that male flowers are probably always absent and the species is an obligate agamosperm, forming fruit without fertilisation.

***Etymology*:** The specific epithet is derived from Latinising the Malay name *manggis.*

9. Garcinia brassii C.T.White, *Proc. Roy. Soc. Queensland* 47: 52 (1936). **Type:** Australia: Queensland. Cook District: Thornton Peak, in low scrub at the summit, 14 March 1932, *L.J. Brass 2277* (holo: BRI).

***Illustrations*:** Christophel & Hyland (1993: 81); Cooper & Cooper (2004: 123); Hyland *et al.* (2010).

Tree to 18 m, dioecious; exudate yellow; bark with fine vertical fissures; branchlets square becoming terete, new twigs mostly red, glabrous. **Leaves** discolorous, coriaceous, glabrous; petioles 5–12 mm long, shallowly channelled on younger growth and on dried specimens, ligulate; lamina obovate or elliptical, 25–125 mm long, 16–63 mm wide, base attenuate or cuneate; apex acute, obtuse or emarginate; margin recurved; venation brochidodromous, primary vein ± flush on upperside but may be raised near base on dry specimens; secondary veins raised on both sides, 12–35 pairs, angle of divergence from primary vein 65–80°, forming loops 0.3–1.2 mm (rarely 4 mm) from margin, intramarginal vein often hidden in the recurved margin; some tertiary veins or veins forking off secondary veins may be present, if so, most diminish and do not reach the intramarginal vein; rarely are reticulations of similar strength to secondary veins present and if they do they are few and near the margin; exudate-containing canals on underside as numerous parallel lines, branched, straight, wriggly or curled, running at angles radiating between primary vein and margin. **Male inflorescences** terminal, a panicle, 3–18-flowered, 19–28 mm long; peduncles 10–21 mm long; bracts obovate or elliptical, keeled, 5–7 mm long, 2–3 mm wide (these may expand into small leaves up to 55 mm long and 21 mm wide), caducous; bracteoles 2–2.5 mm long and *c.* 2 mm wide.

Male flowers: fragrant, diameter 15–28 mm; pedicels absent or up to 6 mm long; sepals 4, 2-whorled, dark red, glabrous, margin thin; outer pair joined, D-shaped or ovate-orbicular, convex, 4–6.5 mm long, 4–6.5 mm wide, coriaceous; inner pair free, orbicular or oblong-orbicular, convex, 7–8 mm long, 6–7 mm wide; petals 4, free, erect or spreading, imbricate, orbicular, convex, 9–14 mm long, 8–14 mm wide, waxy-coriaceous, cream, yellow, pink or reddish, unmarked or with dark red markings, glabrous, margin thin; androecium 4-phalangiate, glabrous; phalanges adnate to petals, obovate or elliptical at anthesis, 5–8 mm long, 5–6 mm wide; anthers several to numerous per phalange, sparsely to densely clustered over phalange, bilobed, *c.* 0.5 mm long and 0.5 mm wide; pistillode rudimentary, attenuate-conical, 1–3.5 mm long. **Female inflorescences** terminal, a solitary flower 10.5–12 mm long; peduncle 1.5–3 mm long; bracts at apex of peduncle triangular, keeled, 3–7 mm long, 2–3 mm wide, caducous; bracteoles 1.5–2 mm long and 2 mm wide. **Female flowers:** fragrant, diameter 13–18 mm; pedicels absent or up to 1.5–3.5 mm long; sepals 4, 2-whorled, coriaceous, green and mostly blushed dark-red towards apex, glabrous, margin thin; outer pair joined, oblong, convex, *c.* 5 mm long and 4 mm wide; inner pair free, broadly ovate or orbicular, convex, 6–8 mm long, 5–7 mm wide; petals 4, free, erect to spreading, orbicular, convex, 8–10 mm long, 8–10 mm wide, waxy-coriaceous, cream or yellowish, often with red markings and often ageing to entirely reddish, glabrous, margin thin; staminodal phalanges 4, erect, adnate to petals, strap-shaped with flabellate apex, *c.* 3.5 mm long and 4 mm wide, apically branched into 5–8 individual filaments *c.* 1 mm long; antherodes 1 or 2 per filament, 0.5– 0.7 mm long; gynoecium globose, 6–7.5 mm long, 4–5 mm wide, glabrous; ovary ovoid, 5–6 mm long, 4–5 mm wide, sessile, 4-locular, locules uniovulate; stigma mass sessile, domed, diameter 4.5–5.5 mm, cream becoming reddish with age or exposure. **Fruiting pedicels** 2–3.5 mm long, 4 sepals persistent at base, **fruit** a fleshy berry, depressed globular, 22–45 mm long, 27–50 mm wide, dark red to blackish, glabrous; stigma shallowly 3 or 4-lobed, diameter 5.5–6.5 mm; seeds 1–4, 12–22 mm long, 10–18 mm wide; testa brown, smooth; aril fleshy, dark red. **Fig. 2A, 3A–C.**

***Additional selected specimens (from 36 examined)*: Queensland.** Cook District: Near peak of walking track to Mt Sorrow, 3 km W of Cape Tribulation, Daintree NP, Sep 2009, *Worboys 825* (CNS); NPR 133, Daintree, summit of Mt Sorrow track, Dec 1998, *Ford 2147* (CNS); VCL Noah, Mt Hemmant, Oct 1975, *Hyland 8490* (CNS); Thornton Peak, Jul 2008, *Jago 7152, Ford & Keith* (BRI); Thornton Peak, Sep 1937, *Brass & White 280* (BRI, K[1]); Thornton Peak, in valley between N and S peaks near campsite on Hilda Creek, Sep 1984, *Clarkson 5588* (CNS); Pinnacle Rock Track, 4.5 km W of Karnak, Jun 1992, *Forster PIF10708, Sankowsky & Tucker* (CNS); Along track to Devils Thumb, Sep 1997, *Jago 4496* (BRI); Mt Misery, E of Mt Spurgeon, 15.7 km NE of Mt Carbine, Nov 1988, *Jessup GJM861, Guymer & McDonald* (BRI); Mossman Bluff *c.* 10 km W of Mossman, Dec 1998, *Fell 1683* (BRI); Near Schiller's hut, Mt Spurgeon, Sep 1972, *Webb 13438 & Tracey* (CNS & BRI); 27.3 km from Rex Highway on Mt Lewis Road, Nov 1990, *Holland 31 & Hind* (NSW); Mt Lewis Road S[South] Mary LA, Nov 1988, *Jessup GJM1526, Guymer & McDonald* (BRI); Mt Lewis FR, 28 km along Mt Lewis Road, Jan 2002, *Forster PIF28164, Booth & Jensen* (BRI); Mt Lewis, on track to Rhododendrons, Sep 2012, *Cooper 2163 & Ford* (CNS); *ditto*, Dec 2012, *Cooper 2207 & Ford* (CNS); Mt Lewis, CSIRO plot EP18, Sep 2012, *Cooper 2162, 2164 & Ford* (CNS).

***Distribution and habitat*:** *Garcinia brassii* is endemic to the Wet Tropics bioregion of north-east Queensland from Mt Sorrow to Mossman Bluff and west to the Mt Lewis –Mt Spurgeon areas (**Map 1**), at altitudes between 500–1300 m. It occurs in rainforest (simple notophyll vine forest, complex notophyll vine forest and simple microphyll vine-fern thicket) on granitic soils.

***Phenology*:** Flowers have been recorded in June, August to November; fruit has been recorded in December and January.

***Etymology*:** The specific epithet is in honour of botanist Leonard J. Brass (1900–1971), collector of the type specimen.

10. Garcinia gibbsiae S.Moore, *J. Bot.* 55: 302 (1917). **Type:** Australia: Queensland. Cook District: Bellenden Ker, forest on long ridge, March 1914, *L.S.Gibbs 6306* (holo: BM[1]; iso: K[1]).

Fig. 3. Flowers. A. ***Garcinia brassii*** ♀, showing stigma and apically branched staminodal phalanges around the ovary (*Cooper 2163 & Ford* [CNS]). B. ***G. brassii*** ♂, showing 4-phalangiate androecium prior to anthesis (*Cooper 2164 & Ford* [CNS]). C. ***G. brassii*** ♂, showing 4-phalangiate androecium post anthesis (*Cooper 2164 & Ford* [CNS]). D. ***G. gibbsiae*** ♀, showing stigma and apically branched staminodal phalanges around ovary (*Cooper 2213 & Cooper* [CNS]). E. ***G. gibbsiae*** ♂, showing androecium of 4 fused phalanges (*Cooper 2212 & Cooper* [CNS]). F. ***G. warrenii*** ♂, showing anthers on 4-phalangiate androecium post anthesis (*Cooper 2158 & Hawkes* [CNS]). G. ***G. russellii*** ♀, showing stigma and apically branched staminodal phalanges around ovary (*Cooper 2150, Russell & Hawkes* [CNS]). H. ***G. russellii*** ♂, showing androecium of 4 fused phalanges (*Cooper 2149, Russell & Hawkes* [CNS]). I. ***G. warrenii*** ♀, showing stigma and apically branched staminodal phalanges around the ovary (*Cooper 2159 & Hawkes* [CNS]). Photos: A, D, E, *W.Cooper*; B, C, F, G, H, I, *T.Hawkes*.

***Illustrations*:** Christophel & Hyland (1993: 81); Cooper & Cooper (1994: 288); Cooper & Cooper (2004: 123); Hyland *et al.* (2010).

Tree to 12 m, dioecious; exudate bright lime-yellow; bark with fine vertical fissures and irregular lenticels; branchlets shallowly ribbed, horizontal, erect or pendulous, glabrous. **Leaves** discolorous, coriaceous, glabrous; petioles 8–20 mm long, channelled, ligulate; lamina oblong-elliptic, ovate, oblanceolate, elliptical or elliptic-obovate, 65–200 mm long, 30–93 mm wide, base cuneate or obtuse, apex acute or obtuse, margin thickened and sometimes remotely recurved; venation paxillate, primary vein raised on both sides; secondary veins numerous (more than 35), ± flush, parallel, angle of divergence with primary vein 70–90°, intramarginal vein on the margin; exudate-containing canals similar on both sides as sparse lines, branched or unbranched, mostly running at a slightly narrower angle than the secondary veins and sometimes crossing over them. **Male inflorescences** terminal or rarely axillary, a solitary flower, pairs, or a 2–8-flowered raceme, up to 38 mm long; peduncle 3–22 mm long; bracts narrowly triangular, convex, 5–10 mm long, 3–4 mm wide, glabrous; bracteoles triangular, convex, *c.* 2 mm long, glabrous. **Male flowers:** not fragrant, diameter 17–46 mm; pedicel absent or up to 2.7 mm long; sepals 4, 2-whorled, convex, may be slightly keeled, green, margin thin; outer pair joined, D-shaped, 5–8 mm long, 7–9 mm wide; inner pair free, orbicular, 5.5–7 mm long, 8–10.5 mm wide; petals 4 (rarely 3), free, orbicular, convex or flat, 11–20 mm long, 11–20 mm wide, thick, waxy, yellow (sometimes blushed with pink), glabrous, margins thin and mostly incurved; androecium of 4 fused phalanges creating a solitary receptacle, rhombic, adnate to petals, divided into 4 shallow lobes at apex, diameter 10–13 mm; anthers numerous, densely clustered over receptacle, subsessile, strap-shaped or wedge-shaped, bithecate, 0.9–1.3 mm long, 0.5–1 mm wide, glabrous; pistillode absent. **Female inflorescences** terminal, solitary or 2-flowered; peduncles 1–2.5 mm long; bracts triangular, keeled, 3–5 mm long, 1.5–2 mm wide, caducous; bracteoles triangular, orbicular or ovate, slightly keeled, *c.* 3 mm long and 2 mm wide, caducous. **Female flowers:** faintly fragrant, diameter 15–22 mm, pedicels 1.5– 2.5 mm long; sepals 4, convex, green, glabrous, margin entire and membranous; outer pair narrowly joined, D-shaped, 5–6.5 mm long, 8–10 mm wide; inner pair free, orbicular, 6.5–8 mm long, 7.5–12 mm wide; petals 4, free, orbicular, convex, 14–17 mm long, 11–15 mm wide, waxy-coriaceous, yellow, glabrous, margin thin; staminodal phalanges 4, free or adjacent pairs fused, adnate to petals, strap-shaped, erect, 2.5–5 mm long, 3–3.5 mm wide, apically branched into 6–9 individual filaments *c.* 1 mm long; antherodes 1 or 2 per filament, erect or introrse, oblate, *c.* 1 mm long and 0.6 mm wide; gynoecium urn-shaped, 7–9-locular, surface irregularly lobed, glabrous; ovary globular, 4–5 mm long, 5–6 mm wide, sessile, 7–9-locular, 1–4 ovules per locule; stigma sessile, domed, 7–9-rayed, diameter 5–6 mm. **Fruiting pedicel** 2–4 mm long, 4 sepals persistent at base; **fruit** a semi-dry berry, top-shaped, broadly-ovoid or truncated-globose, base truncated, apex acute, beaked or rarely truncated, 30–62 mm long, 30–67 mm wide, green, septal radii conspicuous as 7–9 shallow ribs or lines; stigma persistent at apex, 7–9-rayed; locules 7–9, septa thick, coriaceous and entire; seeds 1–4 per locule, ± globular, 10–18 mm long, 7–11 mm wide, testa brown, aril absent. *mountain mangosteen.* **Figs. 2E, 3D & E.**

***Additional selected specimens (from 29 examined)*: Australia. Queensland.** Cook District: Mt Bellenden Ker, east slopes, April 1948, *Brass 18330* (BRI); Mt Bellenden Ker, *c.* 7/8 mile SE of the centre peak, June 1969, *Smith 14690* (BRI); Near junction of E and W Mulgrave River in SFR 310, Upper Goldsborough LA, 19.1 km SSE Little Mulgrave town, Nov 1988, *Jessup GJM1746, Guymer & McDonald* (BRI); Old Mailman's Track, W of Windin Creek, Feb 1995, *Hunter 849* (BRI); SFR 755, Gosschalk LA, EP/34, Nov 1976, *Unwin 117* (CNS); SFR 310, Windin LA, Apr 1973, *Hyland 6702* (CNS); Lamonds [Lamins] Hill, Atherton Tableland, Oct 1949, *Stephens NQ Nat. Club No. 13312* (BRI); SFR 310, Swipers LA, Oct 1963, *Hyland 278RFK* (CNS); Headwaters of Jimpee Creek, *s.dat.*, *Hunter 4522* (CNS); TR 1230, Boonjee LA, Oct 1979, *Moriarty 2678* (CNS); *ditto*, May 1982, *Gray 2550* (CNS); TR 1230, Boonjee LA, Boonjee, walking track to Stockwellia site, June 1992, *Tucker & Sankowsky s.n.* (BRI [AQ546523]); Wooroonooran NP, track to Chuck Lunga Creek, E of Boonjee, *Forster PIF19286 & Tucker* (BRI, CNS); Mt Bartle Frere, 1.8 km WSW Bobbin Bobbin Falls, 4.4 km

NNE Boonjee, Nov 1988, *Jessup GJM1049, Guymer & McDonald* (BRI); Boonjie LA near Bartle Frere track, 0.9 km SE of Bobbin Bobbin Falls, Nov 1988, *Jessup GJM269, Guymer & McDonald* (BRI); Westcott Road, Topaz, Jul 1992, *Cooper 320 & Cooper 320* (CNS); *ditto*, Mar 2013, *Cooper 2212, 2213 & Cooper* (CNS); Topaz, Dec 1970, *Kitchener s.n.* (CNS); Downey Creek SA 34, 24.6 km SE of Millaa Milla, Oct 1988, *Jessup GJM2217, Guymer & McDonald* (BRI).

***Distribution and habitat*:** *Garcinia gibbsiae* is endemic to the Wet Tropics bioregion of north-east Queensland where it occurs in rainforest (complex mesophyll vine forest and simple notophyll vine forest) on basalt soil from the eastern slopes of the Mt Bellenden Ker Range to Downey Creek near Innisfail and west to the Boonjie-Topaz area (**Map 4**), at altitudes between 120 and 1160 m.

***Phenology*:** Flowers have been recorded from February to June; fruit has been recorded from July to January.

***Affinities*:** *Garcinia gibbsiae* appears to be most similar to *G. russellii*. Both species have tough leathery leaves with numerous parallel secondary veins and green fruit with up to three or four seeds in each locule. *G. gibbsiae* is a moderately to densely branched shrub or small tree, with bright lime-yellow exudate, leaf bases which are either cuneate or obtuse and never peltate or cordate, male inflorescences solitary or a few-branched raceme and petals yellow, fruit with spacious locules not completely filled by seeds; locular septa thick, fleshy and entire. *G. russellii* is a slender and sparsely branched shrub or small slender tree with colourless, milky or white exudate, peltate leaves usually with cordate bases, male inflorescences a 9- or more-flowered panicle and petals cream or white, fruit with seeds tightly packed within each locule which mostly cause the exocarp to bulge; locular septa thin, pithy and incomplete.

***Etymology*:** The specific epithet honours British botanist Lilian Suzette Gibbs (1870–1925).

11. Garcinia russellii W.E.Cooper **sp. nov**. Similar to *Garcinia gibbsiae* but differs in the exudate colour (clear or slightly milky versus bright lime-yellow), leaves (peltate versus not peltate), male inflorescences (nine or more flowers versus up to 8-flowered but usually less); fruit septa (thin, pithy and incomplete versus thick, fleshy and entire). **Typus:** Australia: Queensland. Cook District: North of Mossman River, Daintree National Park, 9 July 2011, *W.Cooper 2137, R.Russell, R.Jensen & R.Jago* (holo: CNS [1 sheet + spirit]; iso: 3 sheets to be distributed to BRI, CANB, MO).

Garcinia sp. (Mossman); Cooper & Cooper (2004: 124).

***Illustrations*:** Cooper & Cooper (2004: 124) as *Garcinia* sp. (Mossman).

Shrub or small tree to 6 m, sparsely branched with branches mostly pendulous, dioecious; exudate opaque white, colourless or slightly milky; bark with a few horizontal raised rings at old interpetiolar scars, dotted with small pustules; branchlets slightly 4-sided on new growth and becoming terete on older growth, glabrous. **Leaves** discolorous, coriaceous, glabrous, peltate; petioles 10–25 mm long, attached on underside of lamina; lamina oblong or ovate-oblong, 110–295 mm long, 45–100 mm wide, base cordate or rounded, apex acute and often almost aristulate, margin entire and strongly recurved; venation paxillate, primary vein distinctly raised on both sides, green on upperside and yellow on underside; secondary veins *c.* 100, raised on both sides, angle of divergence from primary vein 70–90°, intramarginal vein on the margin; exudate-containing canals sparse on both sides as unbranched or branched lines, mostly running at a slightly narrower angle than the secondary veins and sometimes crossing over them. **Male inflorescences** terminal, a panicle, 9–39-flowered, 30–62 mm long; peduncle 5–11 mm long; bracts narrowly triangular, convex, 8–9 mm long, *c.* 2.5 mm wide, glabrous; bracteoles triangular, convex, 2–3 mm long, 1.5–2 mm wide. **Male flowers:** not fragrant, diameter 13–27.5 mm, pedicels 2.5–5 mm long; sepals 4, 2-whorled, orbicular, convex, may be slightly keeled; outer pair joined, with margin entire or irregularly lobed, 4–6 mm long, 7–8 m wide, green, glabrous; inner pair free, with margin recurved, entire or irregularly lobed, 4–8 mm long, 4–10 mm wide, pale green, glabrous; petals 4, free, orbicular or oblong-orbicular,

convex, 8.5–15 mm long, 7.5–15 mm wide, white or cream on the inner surface and cream or pale yellow on the outer surface, glabrous; androecium of 4 fused phalanges creating a solitary receptacle, rhombic, adnate to petals and flower base, undivided or divided into 4 shallow lobes at apex, diameter 5.5–11 mm; anthers numerous, densely clustered, subsessile, strap-shaped or broadly wedge-shaped, bithecate, *c.* 2 mm long and 0.5 mm wide, glabrous; fungiform pistillode present in some flowers, *c.* 4.5 mm long, diameter at apex *c.* 2 mm. **Female inflorescences** terminal, a solitary flower (rarely pairs); bracteoles narrowly triangular, convex, *c.* 8.5 mm long and 2.5 mm wide at base, glabrous, caducous. **Females flowers:** not fragrant, diameter 16–25 mm; pedicel *c.* 2 mm long; sepals 4, free, D-shaped, base truncate, apex obtuse, cream; outer pair narrowly joined, *c.* 6.3 mm long and 7.2 mm wide; inner pair free, *c.* 8.3 mm long and 10 mm wide; petals 4, oblong-orbicular, convex, *c.* 13.5 mm long and 10.5 mm wide, cream; staminodal phalanges 4, adnate to petals, somewhat square, apex rounded, antherodes 5–8 per phalange, *c.* 1 mm diameter; gynoecium urn-shaped, *c.* 6 mm long; ovary ovoid or top-shaped, 6–8-locular; stigma domed, 6–8-rayed, diameter *c.* 3.5 mm; ovules 1–4 per locule. **Fruiting pedicels** *c.* 2 mm long; 4 sepals persistent at base; **fruit** a semi-dry berry, top-shaped or broadly ovoid, mostly beaked, beak up to 20 mm long, 6–8 shallow septum-lobes or septum-lines, 60–72 mm long, 50–58 mm wide, green, dull (shiny when unripe), stigma remnants 6–8-rayed, diameter 5–6 mm; locules 6–8; septa thin, transparent, pithy and incomplete; seeds 1–3 per locule, wedge-shaped, 20–22.5 mm long, 18–23 mm wide; testa cream to brown; aril cream and netted, not fleshy. **Fig. 3G & H, 4.**

***Additional selected specimens (from 12 examined)*: Queensland.** Cook District: Finlayvale, NW of Mossman, May 2012, *Hawkes s.n.* (CNS); Mossman Gorge NP on circuit track, Dec 1989, *Jessup GJD3330, Guymer & Dillewaard* (BRI); above the north bank of the Mossman River west of Mossman, Jan 2003, *Jago 6382, Russell & Darwin* (BRI); N of Mossman River in Daintree NP, Dec 2002, *Russell 11* (CNS); North of Mossman River, Daintree NP, Jul 2011, *Cooper 2138, Russell, Jensen & Jago* (CNS); *ditto*, May 2012, *Cooper 2149, 2150, 2151, Russell & Hawkes* (CNS); *ditto*, Nov 2012, *Cooper 2167, Russell, Ford & Sheather* (CNS); *ditto*, Dec 2012, *Cooper 2205, 2206, Russell & Sheather* (CNS).

***Distribution and habitat*:** *Garcinia russellii* is endemic to the Wet Tropics bioregion of north-east Queensland where it is currently known to occur in rainforest (evergreen mesophyll vine forest) on granitic soils in the Mossman Gorge section of Daintree NP and at Finlayvale near Mossman (**Map 4**) at altitudes between 150 and 300 m.

At the type locality *Garcinia russellii* grows as a slender understory tree in rainforest under a canopy of *Backhousia bancroftii* F.M.Bailey & F.Muell. ex F.M.Bailey, *Flindersia bourjotiana* F.Muell., *Lindsayomyrtus racemoides* (Greves) Craven, *Hicksbeachia pilosa* P.H.Weston & *Calamus caryotoides* A.Cunn. ex Mart.

***Phenology*:** Flowers have been recorded in May and July; fruits have been recorded in December.

***Notes*:** Male flowers within the same inflorescence can be inconsistent with some flowers having a fungiform pistillode and others not having any indication of a pistillode.

The exudate-containing canals within the leaves of this species are indistinguishable from *G. gibbsiae* (**Fig. 2E**).

***Affinities*:** *Garcinia russellii* appears to be most similar to *G. gibbsiae*. Both species have tough coriaceous leaves with numerous parallel secondary veins and green fruit with up to three or four seeds within each locule. *G. russellii* is a slender and sparsely branched small slender tree with colourless, milky or white exudate, peltate or almost peltate leaves with distinctly cordate bases, male inflorescences are a 9- or more-flowered panicle and petals cream or white, fruit with seeds tightly packed within each locule which mostly cause the exocarp to bulge; locular septa thin, pithy and incomplete. Whereas, *G. gibbsiae* is a moderately to densely branched small to medium-sized tree, bright lime-yellow exudate, leaf bases which are either cuneate or obtuse and never peltate or cordate, male inflorescences solitary or a few-branched raceme and petals yellow; fruit

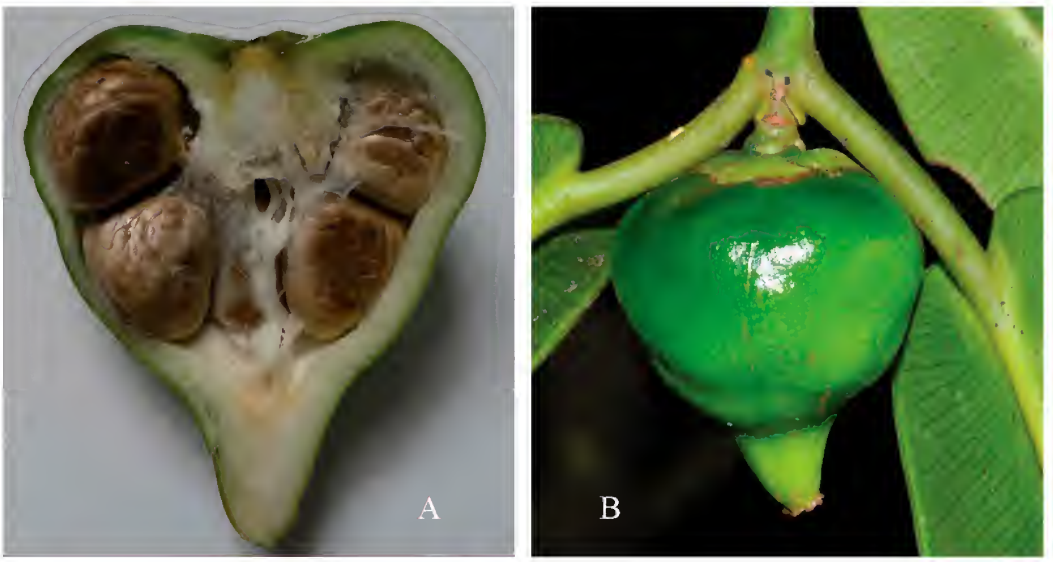


Fig. 4. ***Garcinia russellii*** fruit A. showing longitudinal cross-section and multi-carpelled locules, thin transparent septa and netted aril. B. showing beaked fruit, bracts and terminal attachment to branch (*Cooper 2206, Russell & Sheather* [CNS]). Photos: A, *W.Cooper*, B, *T.Hawkes.*

with seeds usually in spacious locules; locular septa thick, fleshy and entire.

***Etymology*:** The specific epithet is in honour of naturalist and conservationist Rupert Russell (1939–).

12. Garcinia warrenii F.Muell., *Vict. Nat.* 8: 109 (1891). **Type:** Australia: Queensland. Cook District: Coen River, in 1891, *S. Johnson s.n.* (holo: MEL *n.v.*; iso: BRI [AQ0340253[1]], K 000677819[1]).

Garcinia kajewskii C.T.White, *Contr. Arnold Arbor.* 4: 72 (1933). **Type:** Queensland. Cook District: Daintree River, 30 November 1929, *S.F.Kajewski 1418* (holo: BRI [AQ0340243[1]]; iso: S 11-34563[1]).

***Illustrations*:** Christophel & Hyland (1993: 82); Cooper & Cooper (1994:288); Hyland *et al.* (2003); Cooper & Cooper (2004: 123).

Tree to 25 m, dioecious; exudate yellow; dbh to 35 cm; bark tessellated and flakey in large trees, vertically fissured and with vertical lenticels; branchlets square or terete and mostly horizontal, glabrous. **Leaves** discolorous, coriaceous, glabrous; petioles 8–30 mm long, not channelled or becoming shallowly channelled in dry specimens, ligulate; lamina elliptic, oblong-elliptic, ovate, obovate, orbicular or oblanceolate, 40–230 mm long, 28–123 mm wide; base attenuate, cuneate or obtuse; apex acuminate, acute, obtuse, retuse or emarginate; margin not recurved or rarely slightly recurved; venation brochidodromous, often with a second set of loops near margin, primary vein on upperside raised towards base and more or less flush towards apex; secondary veins 24–50, angle of divergence from primary vein 60–90°, forming an intramarginal vein 0.5–4 mm from margin; exudate-containing canals difficult to see on fresh leaves, distinct on underside of dried leaves as numerous unbranched or branched straight or wriggly ± parallel lines, sometimes a second set of canals is visible as more widely spaced long straight lines running at angles 45–80° to primary vein and across the other canal set. **Male inflorescences** terminal or rarely axillary, a panicle, 8–66-flowered, 15–120 mm long; peduncle 5–38 mm long; bracts (which sometimes become full-sized leaves) at peduncle apex, triangular, becoming incurved, glabrous, 8.5–10 mm long, 2–3 mm wide, green with a yellowish primary vein, caducous; bracteoles triangular,

incurved, 2.5–3 mm long, 2.5–3 mm wide, green, caducous. **Male flowers:** fragrant with a clove-like smell, diameter 10–15 mm; pedicels absent or up to 4 mm long; sepals 4, 2-whorled, outer pair joined, D-shaped, convex, 4–5 mm long, 4–5mm wide, green; petals 4, free, erect, imbricate, orbicular or oblong-obovate, may be convex, 5–7 mm long, 4.5–6 mm wide, cream or yellow, glabrous, margin usually recurved and thin; androecium 4-phalangiate; phalanges adnate to petals, obovate-elliptic at anthesis, *c.* 3 mm long, 2–2.5 mm wide; anthers several, most are clustered around phalange margin, bilobed, bithecate, *c.* 0.4 mm long and 0.2 mm wide, glabrous; pistillode rudimentary, attenuate-conical, *c.* 2.5 mm long. **Female inflorescences** terminal, a solitary flower or a 2 or 3(rarely 4)-flowered raceme, 17–25 mm long; peduncles 4–12 mm long; bracts at apex of peduncle triangular, keeled, 6–11 mm long, 3–5 mm wide, green with a yellowish primary vein, glabrous, caducous; bracteoles triangular, 3–4 mm long, 3–4 mm wide, green, caducous. **Female flowers:** fragrant with a clove-like smell, diameter 14–16 mm; pedicels absent or 3–5 mm long; sepals 4, 2-whorled, outer pair joined, inner pair free, D-shaped, convex, 5–6.5 mm long, 8–9 mm wide, green, glabrous, margin thin; petals 4, free, orbicular, convex, 9–11 mm long, 10–12 mm wide, cream or yellow, sometimes blushed with pink, glabrous, margin thin; staminodal phalanges 4, erect, adnate to petals, strap-shaped, *c.* 5 mm long and 3.5 mm wide, apex divided into 4–6 filaments with 1 or 2 antherodes on each side; filaments 1–1.5 mm long; antherodes obovate or rhomboid, *c.* 1 mm long; gynoecium oblong-globose, *c.* 8.5 mm long and 6–8 mm wide; ovary globose or 4-sided, 7–8 mm long and 6–8.5 mm wide, sessile, 4-locular, uniovulate; stigma mass sessile, domed, diameter 7–8 mm, cream becoming pink or reddish with age or exposure. **Fruiting pedicel** 3–5 mm long, 4 sepals persistent at base; **fruit** a fleshy berry, globular or depressed globular, often shortly beaked, 40–58 mm long, 50–75 mm wide, yellow or dark red to blackish; stigma shallowly 3 or 4-lobed or rayed, diameter 8–9.5 mm; seeds 1–4, 32–41 mm long, 23–35 mm wide; testa brown, smooth; aril fleshy, dark red, purple or cream. *native mangosteen*, *Warren's mangosteen*. **Fig. 2G, 3F & I.**

***Additional selected specimens (from 144 examined)*: Papua New Guinea.** Western District: Tarara, Wasi Kussa River, Dec 1936, *Brass 8430* (BRI). **Australia. Northern Territory.** Jessie River, Melville Island, Aug 2000, *Harwood 907* (CNS). **Queensland.** Cook District: Gabba Island, Torres Strait, Mar 2003, *Waterhouse 6592* (BRI); Iama (Yam) Island, Torres Strait, Nov 2007, *Fell 8855 & Stanton* (BRI); Pajinka Lodge, Feb 2001, *Cooper 1453 & Jensen* (CNS); Escarpment of the Great Dividing Range, 18.2 km northeast of Heathlands Ranger Base, Heathlands D and O Reserve, Oct 1993, *Fell 3759, Stanton & Dibella* (BRI); Wattle Hills, Sep 2002, *Sankowsky 1836 & Sankowsky* (BRI); Stone Crossing, Wenlock River, Oct 1980, *Hyland 1075* (CNS); Hey Point, Aug 1985, *Gunness 1899* (BRI); Aurukun, banks of Watson River, Mar 2001, *Smith 4609* (BRI); Ling Creek Spring, Steve Irwin Wildlife Reserve, *c.* 16km due NE of Stone Crossing, Wenlock River, Sep 2009, *McDonald 2009-09-034 & Addicott* (BRI); 12.6 km WNW of Lockhart River Community, Mar 1994, *Fell 4194 & Stanton* (BRI); Nesbit River, Aug 1948, *Brass 19915* (BRI); Rocky River Crossing, Oct 1996, *Cooper 1011 & Cooper* (CNS); Gap Creek, *c.* 38 km S by E of Cooktown, Aug 1959, *Smith 10744* (BRI); Pilgrim Sands, Cape Tribulation, Jan 1993, *Cooper 474 & Cooper* (CNS); Clacherty Road, Julatten, Aug 2012, *Cooper 2158 & Hawkes* (CNS); Euluma Creek Road, Julatten, Aug 2012, *Cooper 2159 & Hawkes* (CNS); SFR 843, Parish of Bellenden Ker, Frenchman Creek, Sep 1986, *Gray 4333* (CNS); Babinda, Aug 2003, *Jago 119* (CNS).

***Distribution and habitat*:** *Garcinia warrenii* occurs in Australia and New Guinea. Within Australia it is recorded from north Queensland where it occurs in rainforest (complex mesophyll vine forest, mesophyll vine forest, complex notophyll vine forest, notophyll vine forest and simple microphyll vine-fern forest) and vine thickets on granitic, basaltic and rarely metamorphic soils from the Torres Strait islands to Babinda, altitude 0–1050 m. There are also two records from Melville Island, in the Northern Territory (**Map 5**).

***Phenology*:** Flowers have been recorded in July, August and September; fruit has been recorded in October, November, December, January and February.

***Etymology*:** The specific epithet is in honour of Dr William Henry Warren (1852–1926), Professor of Engineering at the University of Sydney.

Excluded Names

Garcinia cherryi F.M.Bailey, *Queensl. Fl.* 6: 103 (1902). Basionym of ***Ternstroemia cherryi*** (F.M.Bailey) Merr. ex J.F.Bailey & C.T.White (Theaceae).

Acknowledgements

Christina Zdenek, Brian Venables and John Pritchard are sincerely thanked for making several trips to check for flowers from the female tree of *Garcinia jensenii*. I am especially grateful to Rupert Russell for showing me *G. russellii* in the field, where he initially discovered them and for assisting on numerous trips across the Mossman River during varying water levels to finally collect enough fertile material for a formal description. Andrew Ford, Rigel Jensen and Jeanette Kemp have been invaluable in the field for their good company and sources of expertise. I also thank Frank Zich and Darren Crayn for support and access to the Australian Tropical Herbarium (CNS); Paul Forster for the complicated typification for *G. xanthochymus* and notes on the typification of *G. mestonii*, as well as other assistance; Ben Trupperbäumer for old German translations and Peter Bostock for translation of Latin descriptions as well as creating the maps. Bill Cooper, David Fell, Mark Harrington, Mel Harrison, Tim Hawkes, Bob Jago, Sarah Legge, Stephen McKenna, Steve Murphy, Garry Sankowsky, Allen Sheather, Peter Stanton & Gary Wilson are thanked for much appreciated assistance in various forms. Darren Crayn made valuable suggestions to an earlier manuscript. The curators of BRI, CANB, MEL & NSW are thanked for loans and/or photos of relevant material. Permits to collect were issued by the Queensland Department of Environment and Heritage Protection.

References

Anderson, T. (1874). Guttiferae. In J.D. Hooker, *Flora of British India* 1: 258–278. L.Reeve & Co.: London.

Bailey, F.M. (1889). *Report on new plants, preliminary to general report on botanical results on Meston's expedition to the Bellenden-Ker Range, by F.M. Bailey, F.L.S., Colonial Botanist*, p. 2. Department of Agriculture: Brisbane.

—— (1899). Guttiferae. In *The Queensland Flora*, Part 1, pp. 102–105. H.J.Diddams & Co: Brisbane.

—— (1902). *The Queensland Flora*, Part 6, p. 103. H.J.Diddams & Co: Brisbane.

Canbr (Centre for Australian National Biodiversity Research) (2010). *Australian Tropical Rain Forest Plants Edition 6* (online version), viewed 20 June 2012. http://www.anbg.gov.au/cpbr/cd-keys/rfk/index.html

Chah (2007). *Australian Plant Census.* http://www.anbg.gov.au/cgi-bin/apclist; Australian Plant Names Index, http://www.anbg.gov.au/cgi-bin/apni Accessed November 2011.

Christophel, D.C. & Hyland, B.P.M (1993). *Leaf Atlas of Australian Rain Forest Trees.* CSIRO Publishing: Melbourne.

Cooper, W. & Cooper, W.T. (1994). *Fruits of the Rain Forest.* Geo: Sydney.

—— (2004). *Fruits of the Australian Tropical Rainforest.* Nokomis Editions: Melbourne.

D'Arcy, W.G. (1980). Flora of Panama. Family 123. Guttiferae. *Annals of the Missouri Botanical Garden* 67: 969–1043.

De Candolle, A.P. (1824). Guttiferae. In *Prodromus Systematis Naturalis Regni Vegetabilis* 1: 557–564. Treuttel & Würtz: Paris.

Dowe, J.L. & Broughton, A.D. (2007). F.M.Bailey's ascent of Mt Bellenden-Ker in 1889, and notes on the publication priority of new vascular plant species from the Expedition. *Austrobaileya* 7: 555–566.

—— (2008). F.M.Bailey's taxonomy of A.Meston's collections from the Bellenden Ker Expedition of 1904. *Austrobaileya* 7: 677–679.

Fleming, (circa 1795–1805). Fleming Indian Drawings Collection circa 1795–1805, Natural History Museum, London/Science Photo Library http://www.sciencephoto.com/media/428689/enlarge Accessed July 2013

Hammel, B. (1993). In C.E. Jarvis, F.R. Barrie, D.M. Allan & J.L. Reveal. A list of Linnean generic names and their types. *Regnum Vegetabile* 127: 28.

Hooker, W.J. (1831). *Xanthochymus dulcis.* Sweet-fruited Xanthochymus. *Curtis's Botanical Magazine* 58: t. 3088.

—— (1855). *Garcinia mangostana.* Mangosteen, or Mangostan. *Curtis's Botanical Magazine* 81: t. 4847.

Hyland, B.P.M. (1982). *A revised card key to rainforest trees of North Queensland.* CSIRO: Melbourne.

HYLAND, B.P.M., WHIFFIN, T., CHRISTOPHEL, D.C., GRAY, B. & ELICK, R.W. (2003). *Australian Tropical Rain Forest Plants. Trees, Shrubs and Vines.* CD–ROM. CSIRO Publishing: Melbourne.

HYLAND, B.P.M., WHIFFIN, T., ZICH, F. Edition 6. (2010). *Australian Tropical Rain Forest Plants,* CSIRO. http://www.anbg.gov.au/cpbr/cd-keys/rfk/index.html Accessed October 2011.

JESSUP, L.W. (2007). Clusiaceae. In P.D. Bostock & A.E. Holland (eds.), *Census of the Queensland Flora 2007,* p. 54. Environmental Protection Agency, Brisbane.

—— (2010). Clusiaceae. In P.D. Bostock & A.E. Holland (eds.), *Census of the Queensland Flora 2010,* p. 44. Environmental Protection Agency: Brisbane.

KIRTIKAR, K.R. & BASU, B.D. (1918). *Indian Medicinal Plants*. Sudhinra Nathbasu: Bahadurganj.

KOSTERMANS, A.J.G.H. (1980). Clusiaceae (Guttiferae). In M.D. Dassanayake (ed.), *Flora of Ceylon* 1: 72–110. Amerind Publishing Co. Pvt. Ltd.: New Delhi.

MAHESHWARI, J.K. (1964). Taxonomic studies on Indian Guttiferae III. The genus *Garcinia* L. *s.l. Bulletin of the Botanical Survey of India* 6: 107–135.

MARSDEN, W. (2005). *The History of Sumatra containing an Account of the Government, Laws, Customs and Manners of the Native Inhabitants.* ebook #16768 http://www.gutenberg.org/files/16768/16768-h/16768-h.htm#sumatra-03 Accessed July 2013.

MOORE, S. (1917). A contribution to the phytogeography of Bellenden-Ker. II. Systematic account. *Journal of Botany* 55: 302–310.

MUELLER, F.J.H. (1891). Descriptions of new Australian plants with occasional other annotations (continued). *The Victorian Naturalist* 8(7): 109.

NAZRE, M. (2006). *Taxonomic Revision and Molecular Studies of* Garcinia *Section* Garcinia *(Guttiferae)*, unpublished PhD thesis, The University of Edinburgh. OPARA, L.U., STUDMAN, C.J. & BANKS, N.H. (1997). *Fruit Skin Splitting and Cracking.* In J. Janick (ed.), *Horticultural Reviews* 19(4): 227.

RICHARDS, A.J. (1990a). Studies in *Garcinia*, dioecious tropical forest trees: agamospermy. *Botanical Journal of the Linnean Society* 103: 233–250.

—— (1990b). Studies in *Garcinia*, dioecious tropical forest trees: the origin of mangosteen. *Botanical Journal of the Linnean Society* 103: 301–308.

RICHARDS, J. (2008). *The secret war: a true history of Queensland's Native Police*. University of Queensland Press: St Lucia.

ROBSON, N.K.B. (1960). Guttiferae. In A.W. Excell & H. Wild (eds.), *Flora Zambesiaca* 1(2): 378–404. Crown Agents for Overseas Governments & Administrations: London.

ROXBURGH, W. (1805). *Plants of the Coast of Coromandel* 2: 51, t. 196. W. Bulmer and Co.: London.

—— (1820). *Plants of the Coast of Coromandel* 3: 66. W. Bulmer and Co.: London.

SHARMA, B.P., SINGH, T.D., HANDIQUE, P.J., DEVI, H.S. (2012). Unambiguous identification of *Garcinia xanthochymus* (Clusiaceae) in Manipur, India. *Nebio* 3(3): 7–10.

SINGH, N.P. (1993). Clusiaceae. In B.D. Sharma & M. Sanjappa (eds.), *Flora of India* 86–159. Botanical Survey of India: Calcutta.

SOMPONG, T. (2007). Floral and fruit morphology of some species in *Garcinia* spp. *Songklanakarin Journal of Science and Technology* 29: 245–252.

STEVENS, P.F. (2007). Clusiaceae – Guttiferae. In K. Kubitzki (ed.), *The Families and Genera of Vascular Plants*. 9: 48–66. Springer-Verlag: Berlin/Heidelberg.

SWEENEY, P.W. (2008). Phylogeny and floral diversity in the genus *Garcinia* (Clusiaceae) and relatives. *International Journal of Plant Sciences* 169:1288–1303.

—— (2010). Floral anatomy in *Garcinia nervosa* and *G. xanthochymus* (Clusiaceae): A first step toward understanding the nature of nectaries in *Garcinia*. *Bulletin of the Peabody Museum of Natural History* 51: 157–168.

TE-CHATO, S. (2007). Floral and fruit morphology of some species in *Garcinia* spp. *Songklanakarin Journal of Science Technology* 29: 245–252.

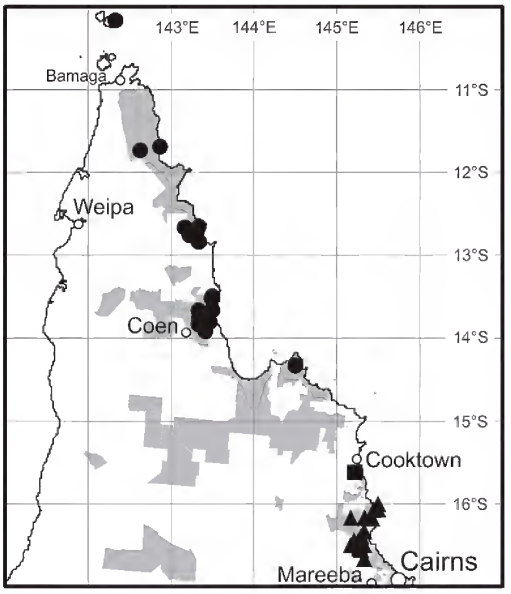
VAN NOOTEN, B.H. (1880). *Fleurs, fruits et feuillages choisis de l'ille de Java: peintes d'apres nature.* C.Muquardt: Bruxelles.

WHITE, C.T. (1933). Ligneous plants collected for the Arnold Arboretum in north Queensland by S.F. Kajewski in 1929. *Contributions from the Arnold Arboretum of Harvard University* 4: 1–113.

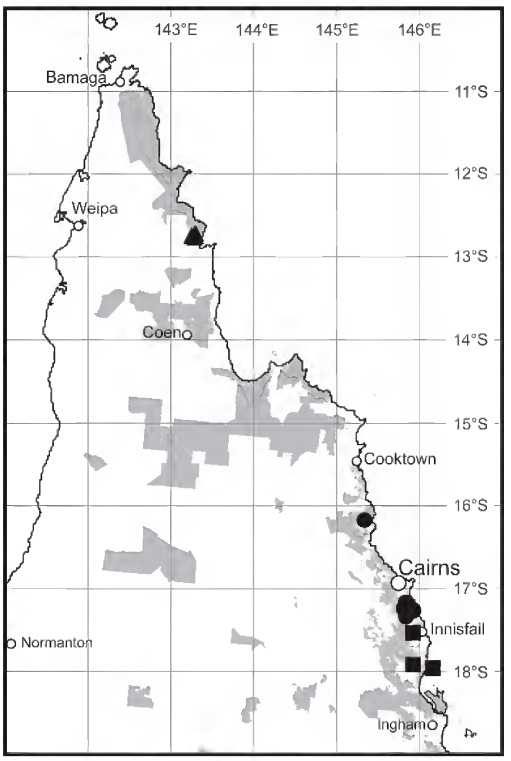
—— (1936). Contribution to the Queensland flora, No. 5. *Proceedings of the Royal Society of Queensland* 47: 51–84.

WIGHT, R. (1840). *Xanthochymus dulcis. Icones Plantarum Indiae Orientalis.* 1: t. 192. J.B.Pharoah: Madras.

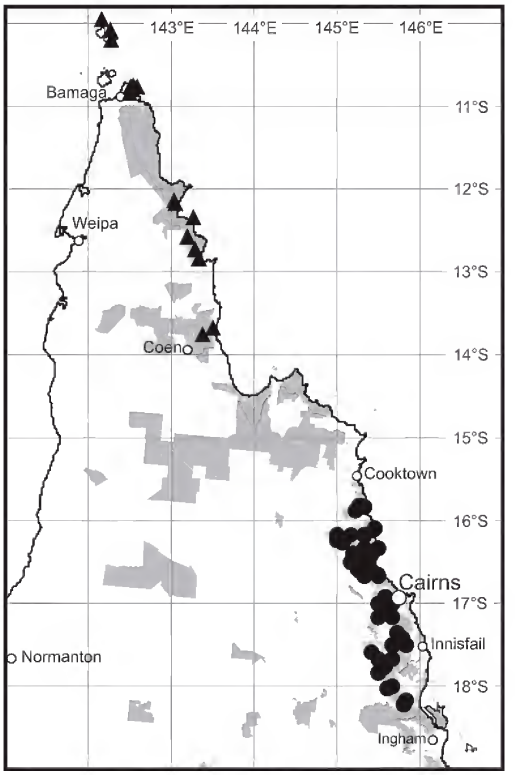
ZODIAC PUBLICATIONS (undated). *Australian Tropical Plants version 4.1 DVD ROM.* Zodiac Publications.



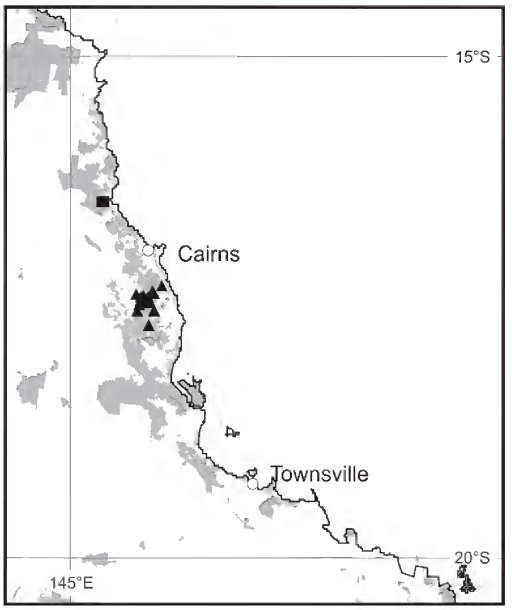
Map 1. Distribution of *Garcinia dulcis* ● (within Australia), *G. brassii* ▲ and **G. livingstonei* ■.



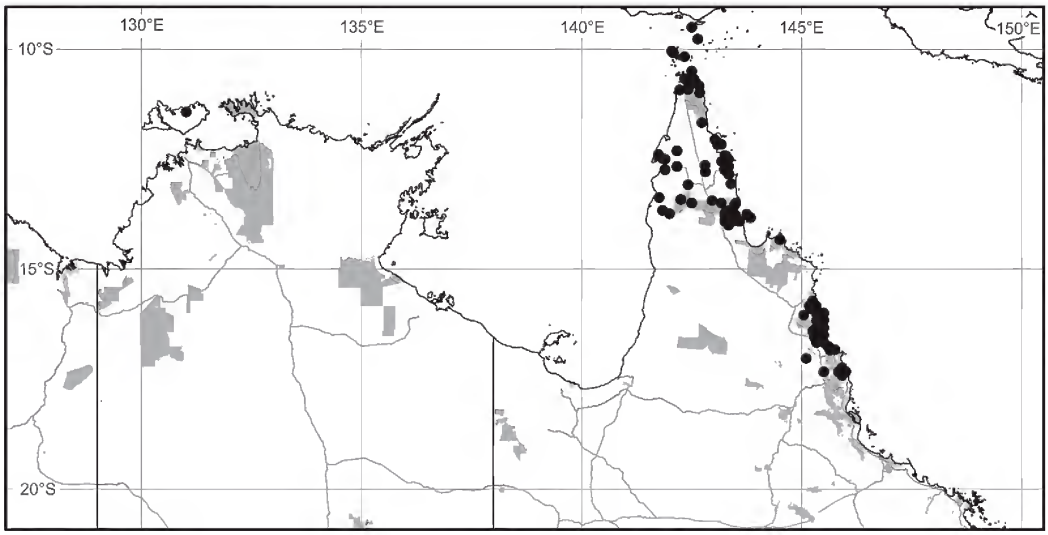
Map 3. Distribution of *Garcinia leggeae* ▲, *G. mestonii* ■ and **G. mangostana* ●.



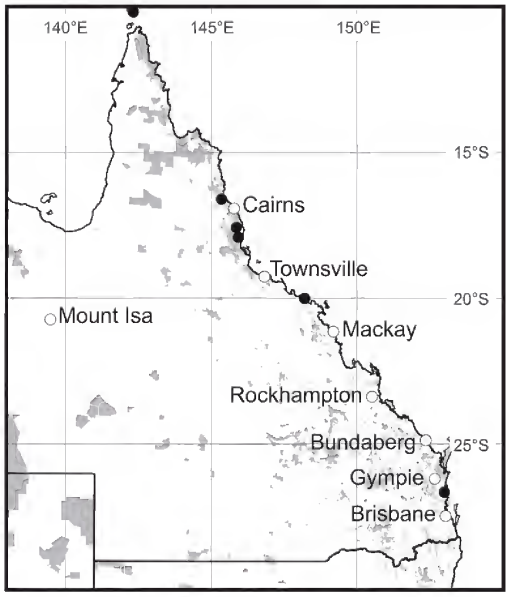
Map 2. Distribution of *Garcinia jensenii* ▲ and *G. zichii* ●.



Map 4. Distribution of *Garcinia gibbsiae* ▲ *and G. russellii* ■.



Map 5. Distribution of *Garcinia warrenii* ● (within Australia).



Map 6. Distribution of **Garcinia xanthochymus* ●.

Reinstatement and revision of *Sphaeromorphaea* DC. and *Ethuliopsis* F.Muell. (Asteraceae: *Plucheinae*)

A.R. Bean

Summary

Bean, A.R. (2013). Reinstatement and revision of *Sphaeromorphaea* DC. and *Ethuliopsis* F.Muell. (Asteraceae: *Plucheinae*). ***Austrobaileya* 9(1): 30–59.** *Sphaeromorphaea* DC. and *Ethuliopsis* F.Muell., historically included in *Epaltes* Cass., are reinstated and taxonomically revised. *Sphaeromorphaea* occurs in Australia, Indian Subcontinent, Indochina, China, eastern Asia, Malesia, Papuasia, northwestern Pacific and southwestern Pacific, and comprises six species. Three new species; *S. ephemera* A.R.Bean, *S. major* A.R.Bean and *S. subintegra* A.R.Bean are described, and two new combinations; *S. harrisii* (F.Muell.) A.R.Bean and *S. littoralis* (Retz.) A.R.Bean are made. *Ethuliopsis* occurs only in Australia and comprises the single species *E. cunninghamii* (Hook.) F.Muell. A neotype is chosen for *Epaltes australis* Less., and lectotypes are chosen for *Artemisia littoralis* Retz., *Ethulia cunninghamii* Hook. and *Epaltes harrisii* F.Muell. Descriptions, illustrations and distribution maps are provided for all taxa. Diagnostic morphological characters and ecological aspects are discussed, and identification keys are provided to the species and to the Australian genera of Subtribe *Plucheinae*.

Key Words: Asteraceae, *Plucheinae*, *Epaltes*, *Ethuliopsis*, *Sphaeromorphaea*, *Sphaeromorphaea ephemera*, *Sphaeromorphaea harrisii*, *Sphaeromorphaea littoralis*, *Sphaeromorphaea major*, *Sphaeromorphaea subintegra*, Australia flora, India flora, China flora, taxonomy, new species, identification key, distribution maps

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Introduction

Sphaeromorphaea DC. and *Ethuliopsis* F.Muell. are often regarded as synonyms of *Epaltes* Cass. (Cooke 1986; Bremer 1994; Anderberg & Eldenas 2007; GRIN 2012) and their histories are intertwined.

Cassini (1818) named the genus *Epaltes* with a single species *Epaltes divaricata* (L.) Cass., native to the Indian subcontinent, China and Indochina. C.F. Lessing added *Epaltes australis* Less., *E. mexicana* Less. and *E. hirsuta* Less. in 1830 and 1832. In the ensuing century, nearly 20 *Epaltes* species were described from all tropical parts of the world.

Sphaeromorphaea was named by De Candolle (1838) with three species at that time, two originating from southern Asia and one from Australia. No other species were subsequently described under that generic name; however, the combination *S. australis* (Less.) Kitam., based on *Epaltes australis* Less., was made in 1936.

In Australia, Mueller (1861) proposed a new genus, *Ethuliopsis*, to accommodate *Ethulia cunninghamii* Hook. Bentham (1867) relegated *Ethuliopsis* to synonymy with *Epaltes*, while maintaining *Epaltes australis*; the two species he placed in *Epaltes* (*E. australis*, *E. cunninghamii* (Hook.) Benth.) were to remain there for well over a century.

Bentham (1873) dealt incompletely with *Sphaeromorphaea*, saying correctly only that it is, in part, synonymous with *Centipeda* Lour. One of the three named species, *S. centipeda* DC., is a nomenclatural synonym of *Centipeda minima* (L.) A.Braun & Asch. Hooker (1882) accepted *Sphaeromorphaea* with a single species (for India), *S. russeliana* DC., and placed the genus next to *Centipeda* in his systematic arrangement.

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Mueller described three further species under *Epaltes* (*E. harrisii* F.Muell., *E. tatei* F.Muell. and *E. pleiochaeta* F.Muell.) from Australia; Moore & Betche (1893) listed *E. pleiochaeta* as an accepted species, and Bailey (1900) listed *E. harrisii* as an accepted species, but neither name ever came into general usage. *Epaltes tatei* is an accepted species that was transferred to a new genus, *Haegiela* P.S.Short & Paul G.Wilson (Short & Wilson 1990), belonging to the Tribe *Gnaphalieae*.

Contemporary Asian flora treatments have used either *Epaltes australis* or *Sphaeromorphaea australis* for the taxa found there. For Taiwan, Li (1978) accepted *S. australis*, but Peng (2004) reversed this, with *Epaltes australis* then the accepted name; Naithani (1995) accepted *S. australis*, placing the genus near *Centipeda* in the Tribe *Anthemideae*; Hu & Wong (2009) used *E. australis* as the accepted name, with *S. australis* given as a synonym.

In recent decades *Epaltes* has been regarded as a heterogenous genus incorporating any Plucheoid taxa whose achenes lack pappus bristles (Leins 1971; Merxmueller *et al.* 1978; Cooke 1986; Anderberg 1991). The present author agrees that *Epaltes* is paraphyletic, and that the Australian species currently referred to that genus belong in *Sphaeromorphaea* DC. or *Ethuliopsis* F.Muell.

Dunlop (2000) was the first author to accept the genus name *Sphaeromorphaea* (and the species *S. australis*) in an Australian flora treatment and some major Australian herbaria subsequently adopted *Sphaeromorphaea* for their state in plant checklists or censuses (Walsh & Stajsic 2007; Short *et al.* 2011). Short & Wilson (1990) foreshadowed the acceptance of the genus name *Ethuliopsis*, but the Australian Plant Census (APC 2012) continued to list it as a synonym of *Epaltes*.

Sphaeromorphaea and *Ethuliopsis* are revised in this paper. Six species of *Sphaeromorphaea* are enumerated, including three new species and two new combinations; all of these species have previously been referred to a broadly circumscribed *Epaltes australis*. They occur in Australia, Indian subcontinent, Indochina, China, eastern Asia, Malesia, Papuasia, northwestern Pacific and southwestern Pacific. *Ethuliopsis* is monotypic, and is endemic to Australia.

Materials and methods

This revision is based on a morphological study of herbarium specimens from A, AD, AMES, BM, BRI, C, CANB, GH, K, LD, MEL, PE, PERTH and TAI. Images of specimens, mainly types, from BM, C, CAL, G-DC, K, M and P have been examined. In addition, the author has collected and studied plants in the field in Queensland, New South Wales and the Northern Territory.

All measurements were made from dried material, using a stereo microscope equipped with a graticule. Commonly used abbreviations in the specimen citations are HS for Homestead, NP (National Park), SF (State Forest).

The distribution maps were compiled using DIVA-GIS Version 7.5.0, using label data of specimens from the herbaria listed above.

Geographical regions are listed according to the scheme of Brummitt (2001); for the generic distributions, the areas cited are Regional Names; for the specimen citations, the areas cited are Level 3 Names. Specimen citations within Queensland are further subdivided into Pastoral districts.

Relationships

Anderberg (1991) provided a cladistic analysis of the subtribe *Plucheinae* based on morphological characters. He reinstated the African genus *Litogyne* Harv., and transferred *Epaltes gariepina* (DC.) Steetz to it, based mainly on the very different shape of the receptacle. *Litogyne* has since gained some acceptance as a distinct genus (Retief & Herman 1997; Beentje 2002).

Anderberg (1991) studied material of the following *Epaltes* species: *E. australis*, *E. brasiliensis* (Link) DC., *E. cunninghamii* and *E. mattfeldii*. Interpretation of his data is fraught because *E. australis* is here

regarded as belonging to *Sphaeromorphaea*, *E. cunninghamii* is regarded as belonging to *Ethuliopsis*, and the generic status of *E. brasiliensis* and *E. mattfeldii* is uncertain. The type species of *Epaltes* (*E. divaricata*) was not included in the analysis.

Anderberg (1991) placed *Thespidium* F.Muell. ex Benth. and *Coleocoma* F.Muell. in the 'Coleocoma group', while *Epaltes* was placed in the 'Pluchea group'. The present author is of the opinion that while *Epaltes sens. str.* and *Ethuliopsis* probably do belong in the 'Pluchea group', *Sphaeromorphaea* belongs to the 'Coleocoma group' and is most closely related to the monotypic genus *Thespidium*. The persistent ebarbellate bristles formed on the achenes of some *Sphaeromorphaea* spp. are very similar to those of *Thespidium basiflorum* (F.Muell.) Benth., and the cylindrical longitudinally-ribbed achenes are a feature of both genera. Leins (1971) had previously proposed a close relationship between *Epaltes australis* and *Thespidium* based on a study of the pollen grains and style morphology.

The molecular study of Anderberg *et al.* (2005) placed *Coleocoma*, *Streptoglossa* Steetz and *Epaltes cunninghamii* (i.e. *Ethuliopsis*) as part of a largely unresolved clade dominated by species of *Pluchea* Cass.

The presence of a coronal pappus is a uniting character for all species of *Sphaeromorphaea* and *Ethuliopsis*. Coronal pappus is not common in Asteraceae, being confined to some genera in Tribe *Anthemideae* and Tribe *Inuleae* (Heywood & Humphries 1977; Mukherjee & Sarkar 2001).

The species of *Sphaeromorphaea* and *Ethuliopsis* differ from *Epaltes sens. str. (E. divaricata)* in a number of significant ways (**Tables 1 & 2**):

Table 1. Morphological character differences between *Sphaeromorphaea* and *Epaltes divaricata*

Characters	*Sphaeromorphaea*	*Epaltes divaricata*
stems	not winged	winged
capitula	borne usually in pairs	borne singly
involucral bracts	mostly obtuse, cartilaginous, incurved	all acute, herbaceous, straight or excurved
marginal florets	conical or lageniform, or filiform with an expanded base	filiform, not significantly expanded at the base
style of disc florets	rather slender, not divided	style arms short and broad, distinctly divided
pappus	a stiff persistent corona, bristles sometimes present	no corona, no bristles
achenes of disc florets	full sized, often indistinguishable from marginal-floret achenes	not formed; ovary vestigial
achene shape	cylindrical	ellipsoidal to obovoid
carpophore	prominent white ring	small, obscure

Table 2. Morphological character differences between *Ethuliopsis* and *Epaltes divaricata*

Characters	*Ethuliopsis*	*Epaltes divaricata*
stems	not winged	winged
sexuality	subdioecious	bisexual
receptacle	hemispherical (in heterogamous capitula)	flat
style of disc florets	rather slender, not divided	style arms short and broad, distinctly divided
pappus	a persistent cylindrical corona, bristles present on disc florets	no corona, no bristles
achene shape and ribbing	lunate; 1-ribbed	ellipsoidal to obovoid; several-ribbed
carpophore	prominent white ring	small, obscure

In *Ethuliopsis*, some plants bear homogamous capitula (with disc florets only), while other plants bear heterogamous capitula (nearly all marginal florets, but with a few disc florets). In *Epaltes divaricata*, all capitula on all plants are heterogamous.

Ecology and distribution

Ethuliopsis cunninghamii is an erect annual herb reaching one metre in height. It is found on alluvial flats with heavy clay soils, in swamps, or beside river channels and lakes. It is endemic to arid and semi-arid eastern Australia.

All *Sphaeromorphaea* species are herbs or small shrubs 15–60 cm high or wide. Some species are seemingly annual (e.g. *S. ephemera*), while other species can develop a substantial taproot and probably live for two or three years, with older stems dying, replaced by new stems shooting from near the base of the plant. They prefer sunny areas with bare soil in grasslands, sedgelands, woodlands or forests. They appear to have no edaphic preference, occurring on soils as diverse as pure beach sand and heavy cracking clays.

All *Sphaeromorphaea* species inhabit places where the soil is intermittently or permanently moist or wet. Poor drainage is readily tolerated, but they will not persist where there is standing water. They can most often be found on alluvial flats, in swamps, or beside rivers and lakes; however, some species can also occur in hilly terrain, where they occupy the wetter microhabitats, such as depressions, drains and gullies.

Most species display a considerable tolerance for high levels of salt in the soil or in the air. One species (*Sphaeromorphaea major* A.R.Bean) is confined to marine couch grasslands, and most other species sometimes inhabit salt affected areas. *S. australis* can grow on coastal headlands, exposed to salty winds. Label data suggest that *S. subintegra* A.R.Bean sometimes grows on serpentinite, a substrate well known to be toxic to many plant species.

Waterbirds are well known as dispersal agents for the seeds of wetland plants (e.g. Figuerola & Green 2002; Soons *et al.* 2008), and although there is no literature documenting the dispersal of *Sphaeromorphaea* or *Ethuliopsis*, it seems reasonable to assume that waterbirds play a major role. This would help explain the distribution of *S. littoralis*, which is widespread from southern Australia to southern Asia. Its apparent absence from Indonesia may be partly due to the

predominance of rainforest communities that are not suitable habitat for the light-loving *Sphaeromorphaea*.

It is interesting to note that *Sphaeromorphaea* and the ecologically comparable genus *Centipeda* (taxonomy revised by Walsh [2001]) have similar distribution patterns, to the extent of possessing a single widespread species shared by southern Asia and Australia, and a centre of diversity in Australia.

Some diagnostic morphological characters

1. Resin globules

Ethuliopsis and most species of *Sphaeromorphaea* have resin globules on the lower and often on the upper leaf surfaces, and on the corollas and achenes. They are shining, transparent and globose, but may be difficult to see in very old herbarium specimens, as with age they degrade and deflate. Their presence, distribution and sometimes their numbers are diagnostic. *S. major* does not have resin globules.

2. Leaf and stem indumentum

Sphaeromorphaea major has glabrous leaves and stems. All other species bear crisped, multicellular, eglandular hairs, at least on young developing leaves and stems. For *S. ephemera* and *Ethuliopsis cunninghamii*, leaves are glabrous at maturity; *S. australis* may be glabrous or sparsely hairy. For *S. littoralis*, *S. harrisii* and *S. subintegra*, at least some hairs persist on mature leaves. Leaf indumentum is particularly variable in *S. littoralis* and *S. harrisii*; sometimes sparsely hairy and sometimes densely hairy on fully expanded leaves.

3. Leaf shape and margins

Sphaeromorphaea species have leaves that at first glance appear petiolate, but they are in fact sessile, as the lamina does extend to the stem in all taxa. In most species, the leaf shape is more or less obovate, but *S. major* is distinguishable by being especially narrow-leaved. No species has entire margins; in *S. subintegra* the margins are denticulate with teeth less than 0.5 mm long, and hence may appear entire without close inspection. In *S. australis*, some large teeth or lobes (>1 mm long) are usually present, often on the basal part of the lamina (the pseudo-petiole). *Sphaeromorphaea littoralis* and *S. harrisii* similarly are often conspicuously toothed on some leaves, with the teeth extending to the basal half of the lamina.

Ethuliopsis cunninghamii leaves are not pseudo-petiolate, and the lamina is broad almost to the base. The leaf margins are denticulate to dentate.

4. Marginal floret shape

The shape of the marginal florets is an important diagnostic character for *Sphaeromorphaea*. In *S. littoralis*, *S. subintegra* and *S. ephemera*, the corolla is consistently conical, tapering more or less evenly from the base to the very narrow apex (e.g. **Fig. 3E**); in *S. australis* and *S. harrisii*, the corolla is consistently lageniform i.e. swollen in appearance, broadest above the base, then tapering rapidly towards the apex (**Figs. 1G, 2C**); in *S. major* and *Ethuliopsis cunninghamii*, the corolla of the marginal florets is filiform (**Figs. 1C, 4H**).

5. Achene features

All *Sphaeromorphaea* achenes are cylindrical, providing an instant distinction from *Ethuliopsis* whose achenes are lunate. *Ethuliopsis* achenes have a single adaxial longitudinal rib, although several anastomosing veins on the surface are often also visible. The number of longitudinal ribs for *Sphaeromorphaea* species varies from 5–14, and is moderately diagnostic for each species. In *S. littoralis* and *S. harrisii*, there is a whorl of antrorse to appressed twin hairs at the base of the achene, with a few twin hairs sometimes occurring also on the achene body. In other species, the twin hairs are nearly always absent, although *S. australis* and *S. subintegra* may occasionally have 1–4 twin hairs at the achene base.

6. Pappus corona

All species of *Sphaeromorphaea* and *Ethuliopsis* have a stiff persistent coronal pappus. In *Ethuliopsis cunninghamii* and in *Sphaeromorphaea major*, the corona is

erect and shortly cylindrical with an entire or fimbriate margin, while in the other species of *Sphaeromorphaea*, it is annular or disc-like, transverse or nearly so, with an entire, pentagonal or erose margin (**Fig. 3G**). The width (and therefore the visibility) of this corona varies with the species; in *S. littoralis*, *S. harrisii* and *S. subintegra* it is relatively broad and easy to see, while in *S. australis* and *S. ephemera*, it is very narrow and difficult to detect.

7. Pappus bristles

In some species of *Sphaeromorphaea* pappus bristles emerge from the margin of the corona. They are consistently ascending, terete, persistent, and shorter than the corolla. With the exception of *S. major*, they lack barbellae. Sometimes only a single bristle is produced, but there may be as many as five. The length and number of bristles produced may differ according to the type of floret; *S. major* can produce up to five bristles on the disc achenes, but not more than three on the marginal achenes. Pappus bristles occur frequently in *S. harrisii* and *S. major*, but only rarely in *S. littoralis* and *S. subintegra*; they have not been observed for *S. australis* and *S. ephemera*. *Ethuliopsis* consistently produces slightly flattened barbellate bristles on the disc florets, but never any bristles on the achenes.

In summary, *Sphaeromorphaea* is characterised by the hemispherical to oblate capitula borne singly or in pairs opposite a leaf; the cartilaginous incurved glabrous involucral bracts; the presence of a coronal pappus (sometimes produced into slender persistent bristles); the cylindrical achenes, formed from all florets (though achenes produced from disc florets may not be fertile), glabrous or with straight twin hairs mainly at the base. *Ethuliopsis* is characterised by the subdioecious habit; the vestigial ovary of the disc florets; white corollas; barbellate pappus bristles on the disc florets; and the glabrous one-ribbed lunate achenes with a cylindrical coronal pappus, obliquely placed on the achene.

Taxonomy

Sphaeromorphaea DC., *Prodr.* 6: 140 (1838). **Type:** *S. russeliana*, *fide* J.R. Drummond in Merrill & Rolfe (1908: 126) [= *S. littoralis*].

Annual or perennial herbs with a well developed rootstock. Latex absent. Indumentum of crisped, multicellular, eglandular hairs. Sessile to very shortly stalked resin globules frequently present on stems, leaves, involucral bracts, corolla and achenes, initially shiny and transparent, becoming opaque and deflated with age. Stems terete, not winged. Leaves alternate, sessile, spreading; margins denticulate, dentate or lyrate; base attenuate, not decurrent. Capitula axillary or leaf-opposed, solitary or in pairs on often short peduncles, hemispherical to depressed-globose, disciform, heterogamous. Involucral bracts subequal in length, cartilaginous, incurved, in 3–4 rows, innermost row conspicuously narrower. Receptacle flat, glabrous, without paleae. Marginal florets fertile, female, without rays; corolla without multicellular hairs, resin globules present or absent, white or pink to purple at anthesis; lobes 3, tiny; style with bulbous base, branches divergent. Disc florets bisexual, usually producing achenes, but in some species infertile; corolla cylindrical to narrowly campanulate, without multicellular hairs, resin globules present or absent, pink to maroon; lobes 4 or 5; anthers tailed, apically obtuse; style bulbous at the base, divided or undivided at apex, sweeping hairs obtuse and extending well down the shaft. Achenes cylindrical, longitudinally ribbed; carpopodium ring-like, prominent, white. Pappus comprising a stiff, transverse or erect annular corona, sometimes produced into short slender persistent bristles. Twin hairs (when present) straight, antrorse to appressed, in a basal whorl, and occasionally on body of achene.

Six species, occurring in Australia, Indian subcontinent, Indochina, China, eastern Asia, Malesia, Papuasia, northwestern Pacific and southwestern Pacific.

Key to the species of *Sphaeromorphaea* using microscopic characters

1 Corolla of marginal florets lageniform **2**
1. Corolla of marginal florets conical or filiform **3**

2 Coronal pappus 0.02–0.05 mm wide, obscure; leaves glabrescent; marginal florets with several resin globules; pappus bristles always absent; achene hairs usually absent, or rarely 1–4 present at base . . . . . **2. S. australis**
2. Coronal pappus 0.05–0.08 mm wide, obvious; leaves persistently hairy; marginal florets with few or no resin globules; pappus bristles frequently present; hairs 5–20 at base of achene . . . . . **3. S. harrisii**

3 Fully expanded leaves sparsely to densely hairy; achenes with several resin globules . . . **4**
3. Fully expanded leaves glabrous; achenes without resin globules **5**

4 Leaves dentate or denticulate, teeth present on basal half of leaf; peduncles 2–14 mm long; achenes with 10–40 hairs, mainly at the base . . . . . **5. S. littoralis**
4. Leaves denticulate, teeth absent from basal half of leaf; peduncles 1.5–3.5 mm long; achene hairs usually absent, or rarely 1–4 present at base . . . **6. S. subintegra**

5 Pappus bristles absent; young stems and leaves sparsely hairy; fertile achenes 0.45–0.7 mm long . . . . . **4. S. ephemera**
5. Pappus bristles present on some florets; all stems and leaves glabrous; fertile achenes 1.0–1.3 mm long . . . . . **1. S. major**

Field key to the species of *Sphaeromorphaea*

1 Leaves narrow, 5.5–14 times longer than broad, without resin globules . . . . . **1. S. major**
1. Leaves broader, 2.3–5.3 times longer than broad, resin globules present **2**

2 Older leaves glabrous, bright green **3**
2. Older leaves sparsely to densely hairy, green to grey-green **4**

3 Annual; achenes without resin globules, marginal florets conical . . . . . **4. S. ephemera**
3. Perennial; achenes with resin globules, marginal florets lageniform . . . . . **2. S. australis**

4 Teeth on leaf margin very small on all leaves and absent from basal half . . **6. S. subintegra**
4. Teeth on leaf margin > 1 mm long on some leaves, teeth present on basal half **5**

5 Most stems erect; capitula almost sessile; pappus bristles frequently present; leaves deeply and irregularly lobed . . . . . **3. S. harrisii**
5. Most stems sprawling; capitula conspicuously pedunculate; pappus bristles rarely present; leaves shortly lobed, lobes fairly regular **6**

6 Leaves grey-green; achenes with numerous twin hairs at base and with conspicuous corona . . . . . **5. S. littoralis**
6. Leaves bright green; achenes lacking twin hairs at base (or just a few present) and with very narrow corona . . . . . **2. S. australis**

Diagnostic characters for *Sphaeromorphaea* species

Achenes with 5–40 twin hairs, mainly at base	*S. harrisii*, *S. littoralis*
Achenes with 1–4 twin hairs at base, or twin hairs absent	*S. australis*, *S. ephemera*, *S. subintegra*, *S. major*
Achene ribs 5–10	*S. australis*, *S. harrisii*, *S. littoralis*, *S. major*
Achene ribs 10–14	*S. australis*, *S. ephemera*, *S. littoralis*, *S. subintegra*
Corona transverse, prominent, > 0.05 mm wide	*S. harrisii*, *S. littoralis*, *S. subintegra*
Corona transverse, obscure, < 0.05 mm wide	*S. australis*, *S. ephemera*
Corona erect, entire or fringed	*S. major*
Marginal floret lageniform	*S. australis*, *S. harrisii*
Marginal floret conical	*S. ephemera*, *S. littoralis*, *S. subintegra*
Marginal floret filiform	*S. major*
Pappus bristles frequently present	*S. harrisii*, *S. major*
Pappus bristles rarely present	*S. littoralis*, *S. subintegra*
Pappus bristles absent	*S. australis*, *S. ephemera*

1. Sphaeromorphaea major A.R.Bean **sp. nov.** affinis *S. australi* sed acheniis longioribus costis longitudinalibus paucioribus, flosculorum discoideorum corolla 2–2.5 mm longa (in *S. australi* 1–1.3 mm) et foliis acheniis corollisque globulis resinae carentibus differens. **Typus:** Queensland. Port Curtis District: 100 metres from Huttonvale track, SE of Sabina Point, Shoalwater Bay Training Area, 8 April 2011, *A.R. Bean 30830 & D. Halford* (holo: BRI [1 sheet + spirit]; iso: BM, CANB, MEL, MO, *distribuendi*).

Prostrate or procumbent perennial shrub to 30 cm high and 60 cm across. Stems glabrous. Leaves linear to narrowly oblanceolate, 11–85 × 2–15 mm, 5.5–14 times longer than broad, glabrous, concolorous, resin globules absent; margins dentate to denticulate, with 3–6 pairs of teeth 0.1–0.7 mm long; apex acute or obtuse. Capitula solitary or in pairs, leaf opposed, hemispherical, 3–4.5 mm long, 4.5–8 mm wide; peduncles 2–28 mm long. Involucral bracts incurved, glabrous; median bracts ovate, 2.7–3.2 × 1.3–1.8 mm, apex acute or obtuse. Marginal florets 75–250, in several rows, female; corolla cylindrical, 1.5–2.4 mm long, apex very narrow, white, without resin globules. Disc florets 16–68, functionally male; corolla cylindrical to narrowly campanulate, 2–2.5 mm long, 0.25–0.35 mm wide near base, 0.4–0.5 mm wide near apex, pink, resin globules absent; lobes 4 or 5, triangular, each 0.4–0.5 mm long; style undivided. Achenes formed from all florets, but those from disc florets infertile. Marginal achenes fertile, cylindrical, 1–1.3 mm long, 0.25–0.3 mm wide, brown; ribs 5–10, white; twin hairs absent or 1–4, resin globules absent. Pappus corona almost erect, 0.02–0.05 mm high, margin entire or fimbriate; pappus bristles absent or with 1–3 bristles up to 1.9 mm long, and (in inland populations) with numerous short bristles. Disc achenes infertile, cylindrical, 0.8–1.7 mm long, 0.3–0.4 mm wide, white; ribs absent; pappus corona erect, white, margin entire or fimbriate; pappus bristles absent or with 1–5 barbellate bristles arising from the corona, up to 1.9 mm long. **Fig. 1A-D**.

***Additional specimens examined*: Queensland.** Port Curtis District: Broad Sound, Sep 1802, *Brown s.n.* (CANB, MEL); Bay of Inlets, Jun 1770, *Banks & Solander s.n.* (BM); 2 km NW of Seahound Hard ramp, Shoalwater Bay Training Area, N of Yeppoon, Feb 2012, *Bean 31610 & Mathieson* (AD, B, BRI, US, W, to be distributed); Ramsay Crossing, squatters

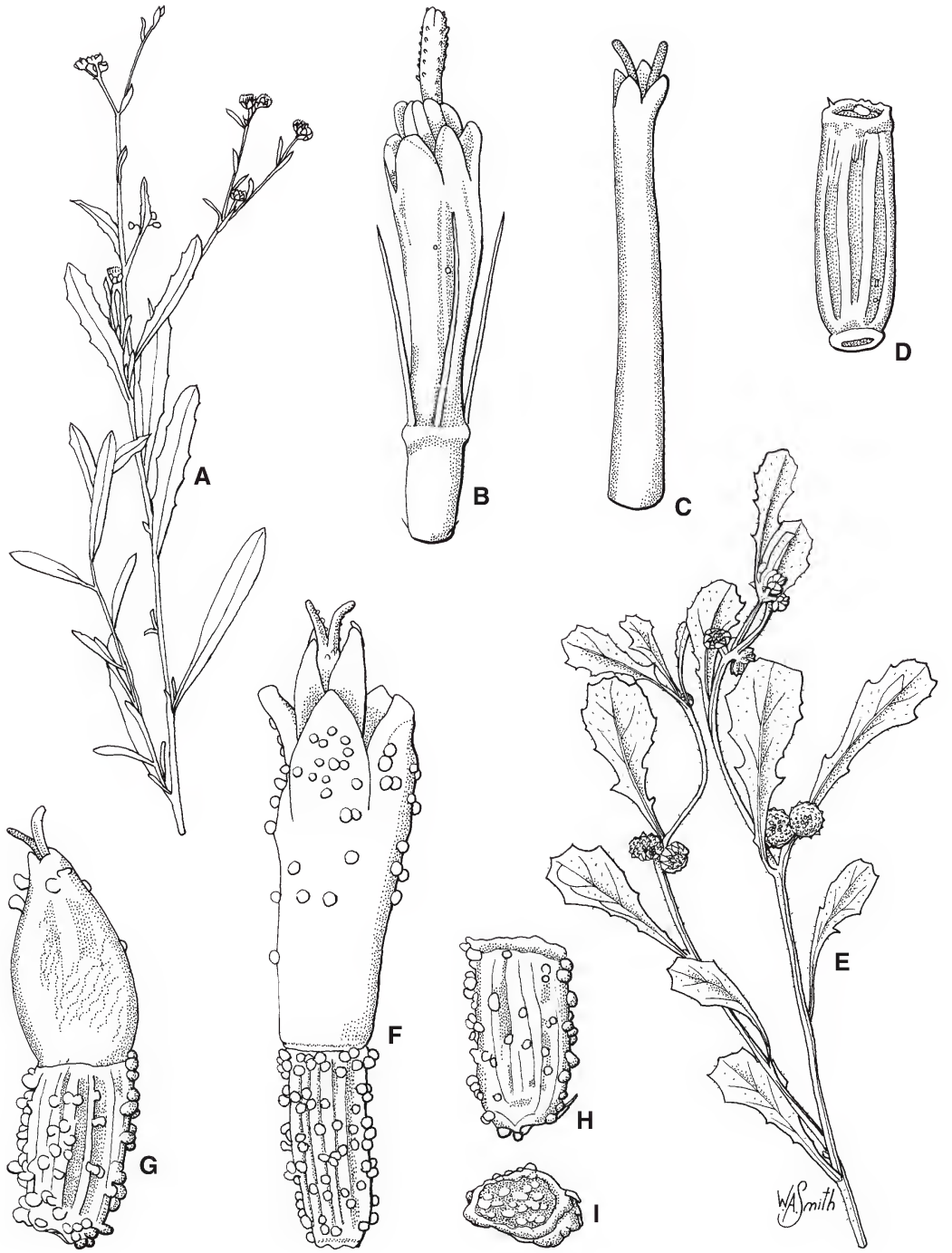

Fig. 1. A–D. ***Sphaeromorphaea major***. A. Flowering branchlet ×0.5. B. disc floret and infertile achene with pappus bristles ×16. C. marginal floret ×32. D. achene ×32. E–I, ***S. australis***. E. flowering branchlet ×1. F. disc floret ×32. G. marginal floret ×32. H. achene, lateral view ×32. I. achene, plan view ×32. A–D from *Bean 30830 & Halford* (BRI); E from *Bean 9548* (BRI); F–I from *Kemp 3362H & Kutt* (BRI). Del. W.Smith.

camp, 40 km NW of Gladstone, near Curtis Island, Dec 2004, *Batianoff 0412502 & Halford* (BRI); Targinnie district, 18.5 km NW of Gladstone, Nov 2011, *Fell DGF QEQ79/1* (BRI). MITCHELL DISTRICT: Bowen Downs, in 1873, *Birch s.n.* (MEL); Second Spring, Edgbaston Reserve, NE of Aramac, Apr 2012, *Bean 31643* (A, BRI, DNA, G, HO, MEL, NSW, to be distributed); Measuring Spring, Edgbaston Reserve, NE of Aramac, Apr 2012, *Bean 31646* (BRI, CANB); Edgbaston, Mar 1998, *Fensham 3464* (BRI). SOUTH KENNEDY DISTRICT: Little Moses Spring, Doongmabulla Station, 165 km NW of Clermont, May 2012, *Danielsen 1555* (BRI).

***Distribution and habitat*:** *Sphaeromorphaea major* is endemic to Queensland. It is known from some coastal locations near Rockhampton, and three inland locations at Edgbaston Reserve, Bowen Downs and Doongmabulla station (**Map 1**). On the coast, it is confined to those salt marsh areas (inundated by spring tides and dominated by grassland of *Sporobolus virginicus* (L.) Kunth) that apparently receive freshwater seepage from adjacent eucalypt or melaleuca forest. At the inland locations, it grows on the margins of artesian springs in open salt-encrusted areas dominated by *Cyperus laevigatus* L., but not where there is surface water.

***Phenology*:** Flowers and fruits have been recorded from September to April.

***Notes*:** Banks and Solander were the first to collect this species, from 'Bay of Inlets' (near Stanage Bay) in 1770, and Solander gave it the manuscript name *Cotula glabrata*. Robert Brown then collected it in 1802; the label on his specimen at BM [Bennett 2131] states that the plant was seen "in paludosis salsis Port 1, Keppel Bay, Shoalwater Bay [&] Broad Sound". 'Port 1' and 'Keppel Bay' are near the southern and northern ends of Curtis Island respectively (Vallance *et al.* 2001), places where there are no modern collections. The area covered by Brown's excursions at 'Broad Sound' (between the present-day towns of Ogmore and Carmila) is also without modern collections. For this species, there was a time lag of 243 years between the first herbarium collection and formal description. This lag figure is surely the highest on record for an Australian plant taxon, and it may well be a record not easily broken. Fontaine *et al.* (2012) found that, for species described in 2007, the average time lag (or 'shelf life') was around 21 years for all species, and around 32 years for plant species.

Sphaeromorphaea major differs from the sympatric *S. australis* by the achenes 1–1.3 mm long (0.65–0.9 mm long in *S. australis*); marginal florets 1.7–2.2 mm long (0.5–0.9 mm long in *S. australis*); leaves without resin globules (always present in *S. australis*, though sometimes hard to see); no resin globules on achenes or corolla (always present in *S. australis*).

The Edgbaston populations have a coronal pappus with a strongly fimbriate margin, while the coastal populations have an entire corona margin. The Doongmabulla specimen is intermediate with regard to this character, with a weakly fimbriate coronal pappus. There seem to be no other consistent morphological differences between the coastal and inland populations.

Sphaeromorphaea major can be distinguished by its narrow leaves and often very long peduncles. It is the only species in which the leaves lack eglandular multicellular hairs and resin globules. Furthermore, its disc florets are functionally male and the achenes produced are infertile, while in the other species the "disc achenes" are usually fully fertile.

***Conservation status*:** *Sphaeromorphaea major* is known from about 400 plants at Edgbaston Reserve near Aramac, on the margins of three springs. The population size at Doongmabulla station is unknown. Its continued existence at Bowen Downs is unknown. The author has observed several hundred plants at Shoalwater Bay Training Area, and Brown's recordings of it suggest that there is a strong possibility of extending the known distribution. However, in view of the very specialised habitat, the total area covered is unlikely to exceed 40 square km. Applying the Red List criteria (IUCN 2001), a status of 'Near Threatened' is recommended.

***Etymology*:** The specific epithet refers to the disc florets, which are larger in this species than in any other species of *Sphaeromorphaea*.

2. Sphaeromorphaea australis (Less.) Kitam., *Acta Phytotax. Geobot.* 5(4): 276 (1936), 6(2): 80 (1937); *Epaltes australis* Less., *Linnaea* 5: 148 (1830), *Syn. Gen. Compos.* 206 (1832); *Erigerodes australe* (Less.) O.Kuntze, *Revis. Gen. Pl.* 1: 335 (1891). **Type:** not cited (B, †). **Neotype (here designated):** Australia: New South Wales. Myall Creek road, Bungawalbin National Park, *c.* 22 km SSE of Casino, 30 December 2011, *A.R. Bean 31450* (neo: BRI [1 sheet + spirit]; iso: CANB, E, K, MEL, NSW, RSA, US, W, to be distributed).

Sphaeromorphaea petiolaris DC., *Prodr.* 6: 140 (1838). **Type:** [Australia: New South Wales.] Port Jackson, undated [in 1819], *C. Gaudichaud* (syn: G-DC, image!; P, image!); Port Jackson, undated [in 1823], *F.W. Sieber 697* (syn: G-DC, image!).

***Illustrations*:** Logan River Branch SGAP (2005: 130); Stephens & Sharp (2009: 44), both as *Epaltes australis*.

Prostrate to ascending perennial herb, to 30 cm high. Stems with sparse multicellular hairs when young, glabrescent. Leaves spathulate, obovate or oblanceolate, 26–70 × 7–21 mm, 2.6–5.3 times longer than broad, discolorous, resin globules present on both surfaces; young leaves with sparse multicellular hairs, often absent at maturity; margins dentate to denticulate, with 4–8 pairs of teeth up to 5 mm long, the longer lobes frequently on the attenuate basal part of the lamina; apex obtuse or acute. Capitula solitary or in pairs, leaf opposed, hemispherical to oblate, 2–3 mm long, 4–5.5 mm wide; peduncles 1–6 mm long. Involucral bracts incurved; median bracts ovate, 1.5–1.9 × 0.8–1.2 mm, glabrous or with a few resin globules on outer surface, apex acute. Marginal florets 150–300, in several rows, female; corolla lageniform, 0.5–0.9 mm long, pink to purple, resin globules few to numerous, apex very narrow. Disc florets 13–34, bisexual or functionally male; corolla narrowly campanulate, 1–1.3 mm long, 0.25–0.3 mm wide near base, 0.4–0.45 mm wide near apex, pink to maroon, resin globules present throughout; lobes 4, triangular, each *c.* 0.2 mm long; style undivided. Achenes formed from all florets, but those from disc florets sometimes infertile, white to pale yellow. Marginal achenes fertile, cylindrical, 0.65–0.9 mm long, 0.2–0.25 mm wide, brown, ribs 8–12, white, twin hairs absent or 1–4 at base; resin globules few to numerous, shining. Pappus corona transverse, obscure, translucent, 0.02–0.05 mm wide, with numerous radial striations, margin entire to erose; pappus bristles absent. **Fig. 1E-I.**

***Additional selected specimens examined*: Taiwan.** Tamsuy [Tan-shui], 1864, *Oldham s.n.* (GH); Houlung, Miaoli County, Aug 1968, *Kao 7364* (TAI). **New Caledonia.** Koutio-Kouéta, Dumbéa, Sep 1971, *McKee 24355* (NOU). **Australia: Western Australia.** 1 km N of Serpentine, Feb 1985, *Keighery 7182* (PERTH); Lambkin Reserve, Serpentine, Apr 1996, *Keighery 14346* (PERTH). **Queensland.** Cook District: Rocky Isles, Great Barrier Reef, *c.* 18 km S of Cooktown, Jun 1969, *Done s.n.* (BRI [AQ7513]). North Kennedy District: Alva Beach, Jun 1949, *Smith 4400* (BRI). South kennedy district: Western edge of Lake Buchanan, Yarrowmere Station, Mar 1998, *Kemp 3362H & Kutt* (BRI). Mitchell District: Myross, east of Aramac, May 2000, *Fensham 3885* (BRI). Leichhardt District: Baralaba – Woorabinda Road, 1.8 km W of Dawson Range, Mar 2005, *Bean 23551* (BRI); Humboldt, 45 km NE of Rolleston, Jan 1996, *Bean 9548* (BRI). Port Curtis District: Livingstone Shire Vegetation Survey, site 227 behind Lammermoon Beach, Sep 1977, *Batianoff 806 & McDonald* (BRI, CANB). Burnett District: Allies Creek SF, Compartment 146, W of Middle Creek Road, Apr 2004, *Halford Q8271 & Jessup* (BRI). Wide Bay District: Old Hollett Road, *c.* 5 km SW of Noosaville, Dec 2003, *Bean 21577* (BRI). Maranoa District: Around barracks, Carellen, *c.* 90 km WNW of Bollon, Mar 2008, *Bean 27456* (BRI). Darling Downs District: Girraween NP, 22 km S of Stanthorpe, Apr 2001, *Batianoff 210534 & Collyer* (BRI). Moreton District: Hay's Landing, Wivenhoe Dam, N of Fernvale, Jan 2001, *Bean 17303* (BRI). **New South Wales.** Tenterfield, May 1921, *Cheel s.n.* (NSW); Pilliga, Nov 1932, *Rupp 15* (NSW); Trial Bay to Laggers Point, NE of Kempsey, Jan 1953, *Constable s.n.* (NSW, US); *c.* 4 km by road W then N of Crowdy Head on road to Diamond Head, Mar 1981, *Haegi 2026* (AD, MEL, NSW); 3 miles [5 km] along Currambean Creek Road, 5 miles [8 km] S of Nowra, Mar 1951, *Ford s.n.* (NSW); Huskisson, Jervis Bay, Apr 1916, *Rodway 4509* (NSW).

***Distribution and habitat*:** *Sphaeromorphaea australis* occurs naturally in Australia and in New Caledonia. In Australia it extends from Ulladulla, New South Wales to Townsville, Queensland (with an outlier further north near Cooktown), and up to 600 km inland e.g. Lake Buchanan, Bollon, Pilliga (**Map 2**). It is naturalised in Taiwan (first collection in 1864) and near Perth, Western Australia (first collection in 1985) (**Map 3**). In New South

Wales and southern Queensland, it occupies a range of habitats in forest dominated by *Eucalyptus* spp., *Acacia harpophylla* F.Muell ex Benth. or *Melaleuca* spp., and sometimes in marine couch grassland adjacent to mangrove trees. Towards the northern end of its native range, the species appears to be increasingly confined to saline habitats, such as coastal salt marsh, artesian springs or the edges of saline inland lakes. Soil ranges from white sands to dark heavy clays.

***Phenology*:** Flowers and fruits can be found in any month of the year.

***Typification*:** Lessing (1830) catalogued all Asteraceae specimens held at the Berlin Botanical Museum (B), wherein he provided a three word description of *Epaltes australis* as a footnote, without mention of the specimen(s) upon which the name is based. Soon after, in his *Synopsis Generum Compositarum*, he (Lessing 1832) expanded the description of *E. australis* slightly, again without referring to the specimen(s) used. He did not explicitly give the country of origin, but did state that the genus is found in "Asiae vel Novae-Hollandiae vel Americae aequinoctialis". The other three species treated (*E. divaricata, E. mexicana, E. hirsuta*) were known to him from India, Mexico and India respectively, so it follows that *E. australis* is the Australian species.

While it is unclear from reading A.P. de Candolle's treatment of *E. australis* (de Candolle 1836) whether he viewed the specimen that Lessing used to describe it, in hindsight it is obvious that he did not. Candolle cited a specimen for *E. australis*, collected by Cunningham from the Lachlan River in New South Wales and thanks to a paper by O.W. Sonder (1853), we know this is not the correct application of the name *Epaltes australis*. Sonder examined both Lessing's specimen at B and the Cunningham specimen cited by de Candolle, and he indicated unambiguously (Sonder 1853: 482) that *E. australis sensu* de Candolle was not that of Lessing, and that *Ethulia cunninghamii* Hook. is synonymous with *E. australis sensu* de Candolle. He further stated (p. 485) that the cited specimens of *Sphaeromorphaea petiolaris* DC. belong to the same taxon as Lessing's (type) specimen of *Epaltes australis*. However, Sonder did not impart any information about the collector or provenance of Lessing's type specimen.

Nearly all material at B was destroyed during World War II (Hiepko 1987), including the type of *E. australis*, and the absence of information about the collector, date of collection or provenance of the type (except 'Novae-Hollandiae') means that there is no starting point to search for potential duplicate specimens. As no known type material exists for *E. australis*, a neotype is here chosen from material collected in "Novae-Hollandiae", i.e. Australia, and from the taxon that occurs around Sydney, the most likely collection site of the original specimen.

***Notes*:** *Sphaeromorphaea australis* is distinguished from other species in the genus by its dark green leaves, the frequent presence of conspicuous lobes on the basal attenuate part of the lamina; the lageniform marginal florets; the narrow and inconspicuous coronal pappus; the lack of pappus bristles; and the absence (usually) of hairs at the base of the achene. Leaves are often glabrous at maturity, but specimens from the more westerly areas have leaves that often retain some hairs at maturity.

In Queensland, its distribution overlaps extensively with *Sphaeromorphaea subintegra*, but both species maintain their identities without any sign of intergradation or hybridization. *S. subintegra* may be differentiated by its pale green leaves with persistent (though often sparse) hairs and denticulate margins (teeth < 0.5 mm long), the conical marginal florets, and the relatively broad and conspicuous coronal pappus.

***Conservation status*:** A common and widespread species.

3. Sphaeromorphaea harrisii (F.Muell.) A.R.Bean **comb. nov.;** *Epaltes harrisii* F.Muell., *Fragm.* 11: 101 (1880); *Erigerodes harrisii* (F.Muell.) O.Kuntze, *Revis. Gen. Pl.* 1: 335 (1891). **Type:** Australia: Queensland. Cook District: Possession Island, in 1880, *C.C. Harris s.n.* (lecto [here designated]: K

000373331; isolecto: MEL 2159948, NSW 582206).

***Illustrations*:** Britten (1901: t. 158), as *Epaltes australis*; Dunlop (2000: 185), as *Sphaeromorphaea australis*.

Erect annual or perennial herb to 35 cm high. Stems with dense multicellular hairs when young, hairs persistent. Leaves spathulate to oblanceolate, 22–61 × 7–21 mm, 2.5–3.8 times longer than broad, discolorous or concolorous, resin globules present on both surfaces; young leaves with dense multicellular hairs, fully expanded leaves sparsely to densely hairy; margins dentate to lyrate, rarely denticulate, with 6–10 pairs of teeth up to 5 mm long; apex acute. Capitula solitary or in pairs, hemispherical to cupular, 3–3.5 mm long, 4.5–6 mm wide; peduncles 1–3 mm long. Involucral bracts incurved; median bracts ovate, 2–2.5 × 0.7–1.1 mm, glabrous, apex acute. Marginal florets 200–300, in several rows, female; corolla lageniform, 0.9–1.3 mm long, maroon to purple, resin globules few or none, apex very narrow. Disc florets 15–31, bisexual; corolla cylindrical, 1.25–1.4 mm long, *c.* 0.3 mm wide near base, *c.* 0.35 mm wide near apex, pink to maroon, resin globules scattered throughout; lobes 4, triangular, 0.2–0.25 mm long; style undivided; pappus bristles sometimes present. Achenes formed from all florets, but those from the disc florets sometimes infertile, white to pale yellow, not ribbed. Marginal achenes fertile, cylindrical, 0.7–1.1 mm long, 0.2–0.3 mm wide, brown, ribs 6–10, white, twin hairs 5–20 at base; resin globules numerous. Pappus corona transverse, pale and translucent, 0.05–0.08 mm wide, margin entire to erose; pappus bristles absent or present, slender, without barbellae, 0–6 per floret, 0.1–1 mm long. **Fig. 2A-E.**

***Additional selected specimens examined*: Papua New Guinea.** Western Province: Arufi, Wassi Kussa River, Jul 1968, *Henty & Katik NGF38641* (A, BRI, CANB, K, L); Bula Plains, Morehead subdistrict, Nov 1972, *Henty & Foreman NGF49355* (A, BRI, CANB, K, L, LAE); Garmari on the Bula Plains, *c.* 30 km S of Bensbach Lodge, Apr 1997, *Mitchell 4696* (BISH, BRI, LAE); Balamuk, Bensbach River, *c.* 9 km S of Bensbach Wildlife Lodge, May 1992, *Waterhouse BMW2503 & Obedi* (BRI). **Australia: Northern Territory.** Nhulunbuy Lagoon, Oct 1993, *Egan 2804* (DNA). **Queensland.** Cook District: Saibai Island, Sep 1994, *Wannan 130* (BRI); [North] Possession Island [Iem Islet], Sep 1792, *Smith & Wiles s.n.* (BM); Possession Island, in 1880, *Harris s.n.* (MEL2162771); Thursday Island, June 1897, *Bailey s.n.* (BRI [AQ247412]); 1 km S of Seisia, 250 m from beach, Nov 1999, *Wannan 1412* (BRI, CANB, NSW); New Holland, in 1770, *Banks & Solander s.n.* (BRI [AQ450752]; MEL); Bolt Head, Temple Bay, Jul 1991, *Forster PIF8985* (BRI, DNA, MEL); Coen River [Pennefather River], Gulf of Carpentaria, Nov 1802, *Brown s.n.* (CANB); 8.5 km NW of Weipa Mission, Dec 1974, *Specht W243 & Salt* (BRI); Evans Landing rubbish dump, Weipa, Aug 1996, *Waterhouse BMW3918* (BRI); 11 km N of the Chester River Crossing, W of the Embley Range, Silver Plains Station, Jun 1992, *Forster PIF10539 et al.* (BRI); 18.6 km from Running Creek on the track to Old Port Stewart, Jun 1993, *Clarkson 10103 & Neldner* (BRI, DNA, L, MEL); Lakefield NP, 29.4 km by road from Hann River Crossing, Aug 2011, *McDonald KRM11779* (BRI); East of mouth of Muck River, Cape Melville NP, Jul 1998, *Bean 13666* (BRI); Lakefield NP, 22.8 km by road N of Ranger base, Aug 2011, *McDonald KRM11776* (BRI); Lizard Island, Nov 1997, *Muir s.n.* (BRI [AQ667812]); Lizard Island, Dec 1974, *Specht LI420 & Specht* (BRI). North Kennedy District: Edmund Kennedy NP, near Cardwell, Jan 1992, *Bean 3912* (BRI, DNA, MEL).

***Distribution and habitat*:** In Australia *Sphaeromorphaea harrisii* occurs along the east coast of Queensland from Cardwell to Cape York and on several of the Torres Strait islands as well as in the north-eastern Northern Territory. It is also found in southern Papua New Guinea (**Map 4**). It grows on a wide range of soil types, from sand to black clay, on floodplains and riverbanks where *Melaleuca* spp. or *Lophostemon suaveolens* (Sol. ex Gaertn.) Peter G.Wilson & J.T.Waterh. are dominant. It also occurs at the base of sand dunes, and in *Sporobolus virginicus* grassland adjacent to mangrove communities.

***Phenology*:** Flowers and fruits can be found in any month of the year.

***Typification*:** The original material of *Epaltes harrisii* (now distributed in K, MEL and NSW) comprises numerous very young plants that bear only one or two capitula. Most capitula are immature; only the material at K has florets at anthesis, hence the K sheet has been selected as the lectotype.

There is a second gathering of *S. harrisii* at MEL (MEL2162771) with the same label details as the type. This sheet comprises three mature plants bearing many flowers and mature achenes. Judging by the description

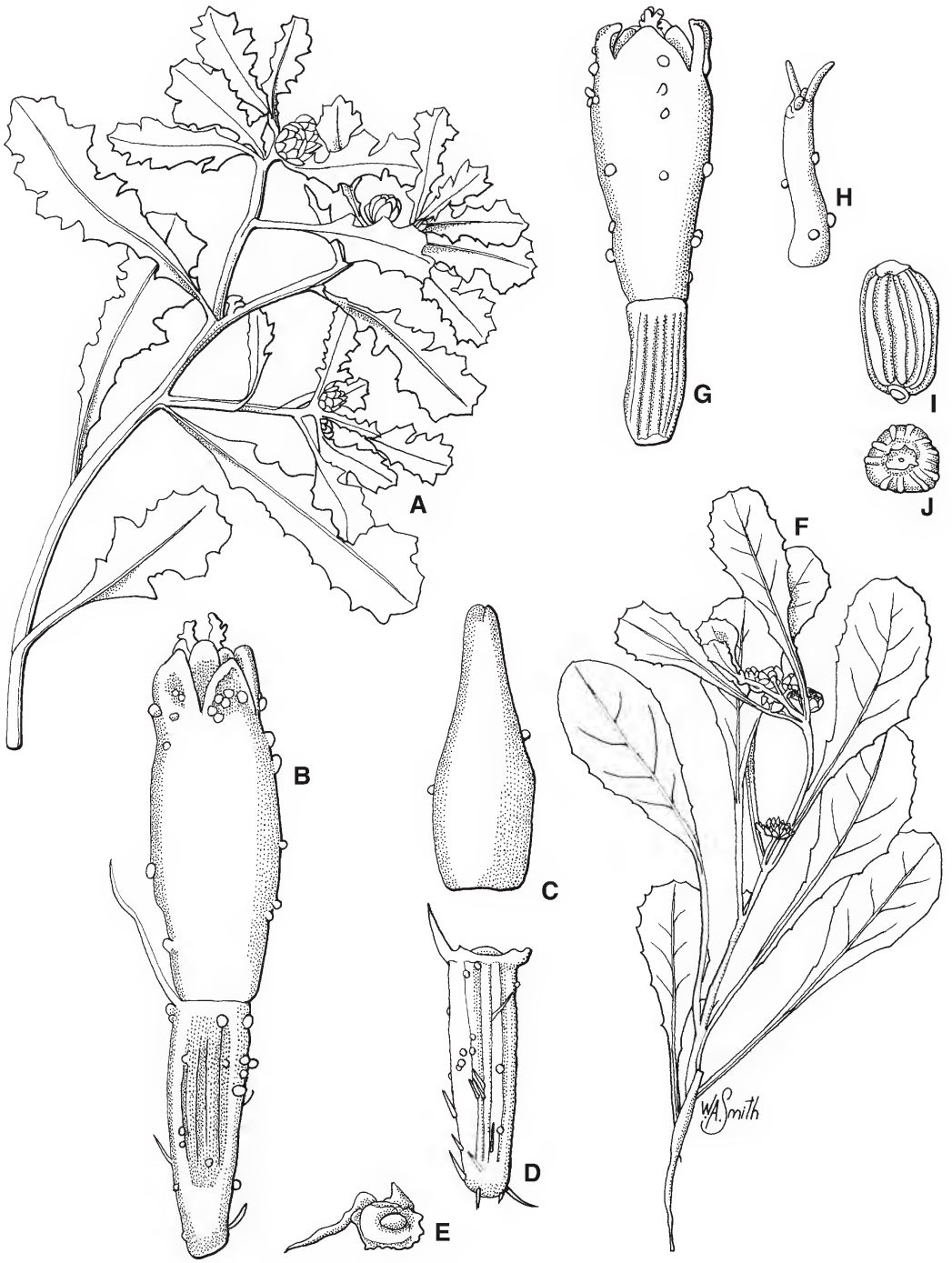

Fig. 2. **A–E**, ***Sphaeromorphaea harrisii***. A. Flowering branchlet ×1. B. disc floret and achene with pappus bristle ×32. C. marginal floret ×32. D. achene, lateral view ×32. E. achene, plan view ×32. **F–J, *S. ephemera***. F. flowering branchlet ×1. G. disc floret and achene ×32. H. marginal floret ×32. I. achene, lateral view ×32. I. achene, plan view ×32. A, from *Forster PIF10539 et al.* (BRI); B–E from *McDonald KRM11779* (BRI); F–J from *Forster PIF22217 & Booth* (BRI). Del. W.Smith.

in the protologue, Mueller did not use this collection when naming the species and hence it cannot be considered a type.

***Notes*:** *Sphaeromorphaea harrisii* is distinctive in the erect stems, the lageniform marginal florets with few or no resin globules; capitula not as broad as in other species; the very short peduncles (often *c.* 1 mm long); the frequent presence of pappus bristles; and the achenes with few (6–10) ribs. It is perhaps closest to *S. australis*, but differs from that species by the more upright habit, persistently hairy leaves, the longer corolla of the marginal florets, the broader coronal pappus and the frequent presence of pappus bristles.

Pappus bristles are present on most *S. harrisii* collections, but completely lacking in others (including the type). There is no geographical basis to this variation. For example, *Specht LI420 & Specht*, from Lizard Island, is without pappus bristles; while *Muir s.n.*, also from Lizard Island, has numerous pappus bristles.

***Conservation status*:** A common and widespread species.

***Etymology*:** This species was named for Charles Christopher Harris (1844–1887), an amateur naturalist. He was borne in Maine, U.S.A., and immigrated to Australia in the 1860s. He arrived at Cooktown in 1873 or 1874, and resided there until his death. He was accidently killed while on board the sailing vessel 'Spey' on 30th April 1887, when the boom struck him on the head (M.Scully pers. comm.; National Library of Australia (2009–onwards)).

4. Sphaeromorphaea ephemera A.R.Bean **sp. nov.** affinis *S. australi* sed habitu annuo, flosculis foemineis conicis et acheniis brevioribus globulis resinae carentibus differens. **Typus:** Australia: Queensland. Gregory North District: Bladensburg National Park, S of Winton, Opalton Road, 19 March 1998, *P.I. Forster PIF22217 & R. Booth* (holo: BRI).

Prostrate to ascending annual herb, to 15 cm high. Stems with sparse multicellular hairs when young, glabrescent. Leaves spathulate to oblanceolate, 14–53 × 5–17 mm, 2.8–4.8 times longer than broad, discolorous, resin globules present on both surfaces; young leaves with sparse multicellular hairs, usually absent at maturity; margins dentate to denticulate, with 3–12 pairs of teeth mostly < 0.5 mm long, but with some up to 2 mm long; apex obtuse. Capitula solitary or in pairs, leaf opposed, hemispherical, 1.5–2 mm long, 4–5 mm wide; peduncles 1–7 mm long. Involucral bracts incurved; median bracts ovate, 1.4–2.3 × 0.5–0.9 mm, glabrous or with a few resin globules on outer surface, apex acute. Marginal florets 100–200, in several rows, female; corolla conical, 0.6–0.7 mm long, pink to purple, broadest at base, few to several resin globules present, apex narrow. Disc florets 13–24, bisexual; corolla cylindrical to narrowly campanulate, 1–1.1 mm long, 0.25–0.3 mm wide near base, 0.25–0.35 mm wide near apex, pink to maroon, resin globules present throughout; lobes 4, each *c.* 0.2 mm long; style undivided. Achenes formed from all florets, cylindrical, tapered at both ends, 0.45–0.7 mm long, 0.15–0.2 mm wide, brown, ribs 10–14, white, twin hairs absent; resin globules absent, or rarely 1 or 2. Pappus corona transverse, obscure, translucent, 0.01–0.04 mm wide, with numerous radial striations, margin entire; pappus bristles absent. **Fig. 2F–J.**

***Additional specimens examined*: Queensland.** South Kennedy District: Cudmore, Apr 1997, *Fensham 3130* (BRI). Mitchell District: Lake Inveresk, 70 km NNE of Muttaburra, Mar 2004, *Cumming 22432 & Thompson* (BRI). Warrego District: Mariala NP, 52.5 km east by road from Adavale, Aug 2009, *Forster PIF35727 & Thomas* (BRI); Road reserve, south of Biloola HS, 2 km off Adavale Road, west of Charleville, May 2010, *Wang JW0180* (BRI); 60 km NW [actually WSW] of Charleville, off the Diamantina Developmental Road, Jun 1976, *Purdie 373D* (BRI).

***Distribution and habitat*:** Endemic to western Queensland, between Adavale and Winton (**Map 1**). Most occurrences are along drainage lines under shrubland of *Acacia aneura* F.Muell. ex Benth., often with emergent *Eucalyptus populnea* F.Muell., and in red clayey soils. One site is on the margins of a salt lake, with fine sandy soil.

***Phenology*:** Flowers and fruits have been recorded from March to August.

***Affinities*:** *Sphaeromorphaea ephemera* is apparently related to *S. australis*, but differs by the conical marginal florets, the annual habit, and the shorter achenes that lack resin globules. *S. ephemera* differs from *S. littoralis* by the glabrescent leaves, the shorter achenes that lack resin globules, the absence of twin hairs on the achenes, and the narrower pappus corona.

***Conservation status*:** Data deficient. While the species is known from just a few specimens, it is potentially common.

***Etymology*:** From the Greek *ephemeros*, meaning 'short-lived'.

5. Sphaeromorphaea littoralis (Retz.) A.R.Bean **comb. nov.**; *Artemisia littoralis* Retz., *Observ. Bot.* 5, p. 28 (1789); *Epaltes littoralis* (Retz.) Less., *Linnaea* 6: 151 (1831). **Type:** seashores of eastern India, undated [1768–1785], *J.G. Koenig s.n.* (lecto, here designated: C 10007263, image!).

Epaltes hirsuta Less., *Syn. Gen. Compos.* 206 (1832). **Type:** 'In India orientali lecta in herbario Thunbergiano', *J.P. Röttler s.n.*, *n.v.*

Cotula quinqueloba Blanco, *Fl. Filip. [F.M. Blanco]* 626 (1837), *nom. illeg. non* L.f. (1782).

Sphaeromorphaea russeliana DC., *Prodr.* 6: 140 (early Jan 1838); in Deless., *Icon. Sel.* 4, t. 49 (Feb 1838); *Sphaeromorphaea russeliana* DC. var. *russeliana*, *Prodr.* 6: 140 (early Jan 1838); in Deless., *Icon. Sel.* 4, t. 49 (Feb 1838); *Centipeda russeliana* (DC.) F.Muell. as '*russelliana*', *Fragm.* 8: 142 (1874). **Type:** India. The Circars, undated [1781–1790], *P. Russell s.n.* (syn: G-DC, image!; syn: K-W, image!).

Cotula russeliana Wall., *Numer. List [Wallich]* 3240 (1831), *nomen nudum*

***Illustrations*:** Gagnepain (1924: 557), as *Sphaeromorphaea russeliana*; Cunningham *et al.* (2011: 685), as *Epaltes australis*.

Prostrate to sprawling perennial herb, to 25 cm high. Stems with dense multicellular hairs when young, hairs persisting at maturity. Leaves spathulate to oblanceolate or obovate, 9–60 × 4–15 mm, 2.3–4.8 times longer than broad, concolorous, resin globules present on both surfaces; young leaves densely hairy, hairs sparse to dense at maturity; margins dentate to denticulate, with 4–14 pairs of teeth usually less than 1 mm long, but occasionally up to 2 mm long; apex acute. Capitula solitary or in pairs, hemispherical, 2.5–3.5 mm long, 3.5–7 mm wide; peduncles 2–14 mm long. Involucral bracts incurved, glabrous; median bracts ovate, 1.6–2.3 × 0.8–1.2 mm, glabrous or with few to many resin globules on outer surface, apex acute. Marginal florets *c.* 200, in several rows, female; corolla conical, 0.7–1.2 mm long, pink to purple, resin globules numerous, apex very narrow. Disc florets 16–40, bisexual; corolla cylindrical, 1.1–1.4 mm long, 0.25–0.4 mm wide, pink, resin globules present throughout; lobes 4, triangular, each 0.2–0.3 mm long; style undivided, arms parallel. Achenes formed from all florets, 0.7–1.3 mm long, 0.25–0.35 mm wide, brown, ribs 8–14; twin hairs 10–40, mainly at base but with some scattered above; resin globules numerous, shining. Pappus corona transverse, circular or somewhat pentagonal, 0.05–0.09 mm wide, with numerous radial striations, margin entire, erose or rarely toothed; pappus bristles usually absent, rarely present. **Fig. 3.**

***Additional selected specimens examined*: India.** Hazaribagh, Apr 1884, *Clarke 34806* (K); Eastern India, *s.dat.*, *Koenig s.n.* (LD); Visakhapatnam, Waltan Beach near university, Sep 1969, *Rao 7101* (CAL). **China Southeast.** Chung Chi college, Hong Kong, Apr 1972, *Hu 11888* (A, K, US); Nanning, Guangxi province, Nov 1935, *Liang 67192* (PE); Yongning, Guangzi province, Jul 1958, *Zhong A62026* (PE). **Hainan:** Yaichow, Hainan Island, Sep 1933, *Liang 62870* (GH, US); Danzhou county, Hainan, May 1928, *Tsang 16813* (PE, US). **Thailand.** Nawng Kai, Chaiyaburi, Feb 1924, *Kerr 8543* (BM); Klong Hoy Kong, Songkla province, May 1986, *Maxwell 86-305* (A); Kao Sabab, Chantaburi, Feb 1935, *Seidenfaden 2735* (C). **Vietnam.** Near beach, Tourane, May–Jul 1927, *Clemens & Clemens 3079* (BM, K, US); Phu Yen province, Jan 1936, *Petelot 6285* (GH, US); Nha Trang, *s.dat.*, *Poilane 6046* (K, US). **Malaysia.** Near Kampong Padangnegeri, Kuala Trengganu, Jul 1953, *Sinclair 39806 & Salleh* (BM); Tumpat, Kota Bahru, Feb 1917, *Ridley 535* (K). **Philippines.** Manila, Jan 1915, *Merrill Species Blancoanae No 773* (AMES, BM, CAL, GH, NSW, US); Caloocan, province of Rizal, Luzon, Nov 1903, *Merrill 3655* (US). **Marianas.** southern end of Cabras Island, Guam, Mar 1966, *Evans 1673* (US); Waste ground just inland from Asan Point, Guam, Jun 1983, *Raulerson 4561* (US). **Australia: Western Australia**. Piccaninny Creek Gorge, 15 km SE of Bungle Bungle Outcamp, Bungle Bungle Range, Apr 1985, *Blackwell BB297* (PERTH); King Edward River, old CRA

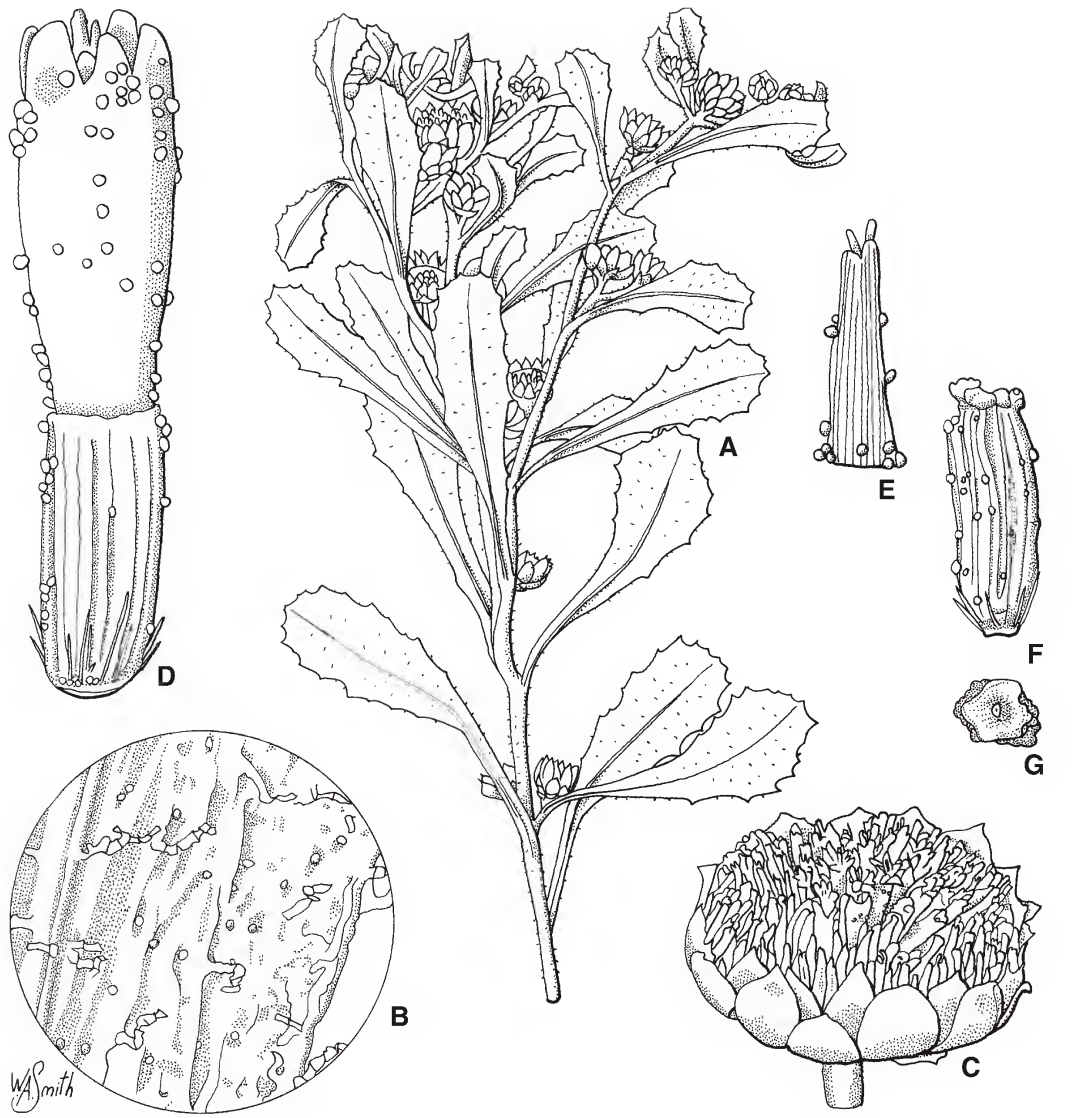

Fig. 3. ***Sphaeromorphaea littoralis***. A. Flowering branchlet ×1.5. B. leaf surface with resin globules and eglandular multicellular hairs ×24. C. flowering capitulum ×8. D. disc floret and achene ×32. E. marginal floret ×32. F. achene, lateral view ×32. G. achene, plan view ×32. A–B from *Bean 23777* (BRI); C from *Brass 8806* (BRI); D–G from *Badman 1473* (AD). Del. W.Smith.

campsite, 1 km S of track to old Mitchell River Station, Jun 1988, *Edinger 541* (DNA, PERTH); Drysdale River above Mogurnda Creek, Drysdale River NP, Aug 1975, *George 13570* (CANB, PERTH). **Northern Territory.** 1.5 km NE of Fish River Gorge in China Wall, Barkly Tableland, Jun 1974, *Kanis 1823* (CANB, DNA, L, US); SE corner of entry to Lake Surprise, Mar 1973, *Maconochie 1672* (DNA, MO, NSW); Mary Ann Dam, *c.* 5km NE of Tennant Creek, May 2005, *Bean 23777* (BRI); *c.* 12 miles [*c.*19 km] NE Finniss River HS, Oct 1971, *Must 842* (CANB, DNA, NSW); Near mouth of Foelsche River, Jul 1948, *Perry 1829* (AD, BRI, CANB, MEL, NSW, US). **South Australia**. Carruranna Waterhole, Cooper Creek, 32 km WNW of Etadunna HS, Feb 1984, *Badman 1473* (AD, BRI, CANB, MEL, NSW); *c.* 1 km N of Big Bend S of Swan Reach, May 1973, *Donner 4113* (AD, BRI); Sunnyside opposite Mypolonga on riverbank, Dec 1961, *Symon 1926* (AD,

BRI). **Queensland.** Cook District: Cumberland, Gilbert River, May 1937, *Brass 8806* (BRI). Burke District: eastern shore of Lake Moondarra, 16 km NNE of Mt Isa, Oct 1997, *Fraser 245* (A, CANB). Mitchell District: Yalleroi, Mar 1946, *Clemens s.n.* (BRI [AQ247452]; GH). Gregory North District: SE edge of Lake Machattie, *c.* 70 km SE of Bedourie, May 2007, *Bean 26406* (BRI). Warrego District: Currawinya NP, Lake Numalla, Mar 1996, *Forster PIF18688* (BRI). **New South Wales.** Cobar, Sep 1910, *Abrahams 387* (NSW); 4 miles [6 km] S of Gwabegar, between Baradine and Pilliga, Nov 1967, *McGillivray 2746* (NSW); Cobham Lake, *c.* 32 km SSE of Milparinka, Mar 1972, *Milthorpe 711* (NSW). **Victoria.** Dimboola, Feb 1901, *D'Alton s.n.* (NSW); Post No 7 on Hattah Nature Drive, Hattah NP, Jan 1989, *D'Aubert 483* (MEL, NSW); On SW side of Lake Lockie, 465 m NNE (at 188 degrees) from the E end of Lockie Track, Mar 2007, *Stajsic 4364* (MEL, NSW).

***Distribution and habitat*:** *Sphaeromorphaea littoralis* is widely distributed in southern Asia, with native occurrences in India, Thailand, Vietnam, Malaya, Philippines and southeastern China. It is naturalised on the island of Guam (**Map 6**). In Australia, it is indigenous in the Kimberley region of Western Australia, South Australia, Northern Territory, western Queensland, western New South Wales and north-western Victoria (**Map 5**). The species inhabits sunny places on the margins of creeks and dams, saline coastal flats and swamps, and in Australia extends into areas receiving very low annual rainfall. Soils are variable.

***Phenology*:** Flowers and fruits may be found at any time of the year.

***Typification*:** I am aware of just two specimens of *Artemisia littoralis* that were collected by J.G. Koenig – one at C and one at LD. The LD specimen is notable for the presence of 1 or 2 pappus bristles, up to 0.6 mm long, on many of its achenes. The specimen at C lacks these bristles, and it is therefore deduced that these two specimens were from separate gatherings. The C specimen is superior in quality, and pappus bristles are not mentioned in the protologue; hence it is chosen as the lectotype.

Type material of *Epaltes hirsuta* was sought from all herbaria that are listed as having collections of C.P. Thunberg or J.P. Röttler (HUH 2012), but without success. However, I consider it a synonym of *S. littoralis*; the words "capitulis solitariis vel geminis" given in the protologue strongly suggests that *E. hirsuta* is a *Sphaeromorphaea*, and the "tota hirsuta" accords with the hairy Indian form of *S. littoralis*.

***Notes*:** *Sphaeromorphaea littoralis* differs from *S. australis* by the grey-green hairy leaves (green glabrous leaves in *S. australis*); the conical-shaped marginal florets that have numerous resin globules (lageniform florets with few resin globules for *S. australis*); the prominent corona on the achenes; and the numerous hairs at the base of the achene.

Sphaeromorphaea littoralis differs from *S. subintegra* by the longer teeth on the leaf margins, presence of teeth on the basal half of the leaves, fully expanded leaves moderately to densely hairy, mostly longer peduncles (to 14 mm, versus 1.5–3.5 for *S. subintegra*), and the presence of numerous antrorse hairs at the base of the achene.

Australian specimens of *S. littoralis* tend to have larger leaves than is usual for Asian specimens. Indian and northern/central Australian specimens are generally densely hairy, while specimens from south-east Asia (e.g. Thailand, China) and around the Murray River in southern Australia are generally only sparsely hairy. According to Cunningham *et al.* (2011), it is completely ignored by domestic livestock.

The collector of the type of *S. russeliana* was Patrick Russell, usually spelt with two "l's" (Hawgood 1994). However, early references (Wallich 1831; Wight 1831; De Candolle 1838) cited his surname as 'Russel', while Lowndes (1834) cited his surname as 'Russel' or 'Russell'. The spelling of the epithet 'russeliana' by de Candolle (1838) was clearly intentional and that spelling must be maintained (Art. 60).

Wallich (1831) included a Russell manuscript name (*Artemisia chrysanthemum*) as a synonym of his *Cotula russeliana* [Cat. 3240]. The latter, also a *nomen nudum*, was later validated as *Sphaeromorphaea russelliana* DC. The epithet *chrysanthemum* means 'golden-yellow flowers', and so some later accounts (Hooker 1882; Li 1978; Naithani 1995) and some specimen labels have stated

that *Sphaeromorphaea* has yellow flowers. All taxa and populations of *Sphaeromorphaea* known to the present author have pink, purple, maroon or (rarely) white florets, and the occurrence of yellow flowered populations is considered highly unlikely. It is probable that Russell's manuscript name referred to another species *e.g. Grangea maderaspatana* (L.) Poir., and Wallich merely misapplied it.

Sphaeromorphaea littoralis is naturalised at Guam, being first recorded in 1966 (Fosberg & Sachet 1980), adjacent to the Naval Base.

***Conservation status*:** A common and widespread species.

6. Sphaeromorphaea subintegra A.R.Bean **sp. nov.** affinis *S. australi* sed in foliis dentibus aequabiliter parvis, pappo coronali comparate lato et conspicuo, pilis persistentibus in foliis maturis et corolla foeminea conica (in *S. australi* lageniformi) differens. **Typus:** Australia: Queensland. South Kennedy District: Lambert Beach, Slade Point, Mackay, 16 July 1992, *G.N. Batianoff 9207103 & H.A. Dillewaard* (holo: BRI; iso: MEL).

Prostrate to ascending perennial herb, to 25 cm high. Stems with sparse to dense multicellular hairs when young, hairs ± persistent. Leaves spathulate to obovate, 14–50 × 4–19 mm, 2.4–3.7 times longer than broad, discolorous, resin globules present on both surfaces; young leaves with moderately dense multicellular hairs, some hairs persisting at maturity; margins denticulate, with 3–12 pairs of small teeth < 0.5 mm long; apex obtuse. Capitula solitary or in pairs, leaf-opposed, hemispherical, 2–3 mm long, 5–6 mm wide; peduncles 1.5–3.5 mm long. Involucral bracts incurved; median bracts 1.5–2.5 × 0.8–0.9 mm, glabrous or with a few resin globules on outer surface, apex acute. Marginal florets 150–300, in several rows, female; corolla conical, 0.6–0.9(–1) mm long, mauve to purple, broadest at base, with few to numerous resin globules; apex narrow. Disc florets 22–44, bisexual; corolla cylindrical to narrowly campanulate, 0.9–1.3 mm long, 0.25–0.35 mm wide near base, 0.25–0.4 mm wide near apex, pink to maroon, resin globules numerous; lobes 4, triangular, each 0.15–0.25 mm long; style undivided. Achenes formed from all florets, cylindrical, 0.7–0.9 mm long, 0.25–0.3 mm wide, brown, ribs 10–14, twin hairs absent or 1–4 at base; resin globules numerous, shining. Pappus corona transverse, obvious, white to grey, 0.05–0.08 mm wide, margin entire to erose; pappus bristles absent or very rarely present. **Fig. 4A-E.**

***Additional selected specimens examined*: Papua New Guinea.** Milne Bay Province: Narian, Misima Island, Aug 1956, *Brass 27606* (A); Joe's Landing, Sudest Island, Aug 1956, *Brass 27780* (A, US). Western Province: Daru, near airstrip, Jun 1973, *Henty NGF49517* (A, BRI); Daru Island, Sep 1963, *Womersley NGF17786* (BRI). **New Caledonia.** Presqu'île de Ouano, Sep 1971, *Raynal 16504* (NOU). **Australia: Queensland.** Cook District: Booby Island, Great Barrier Reef, *c.* 34 km from Thursday Island, Jul 1969, *Heatwole s.n.* (BRI [AQ8142]); East of the Mossman to Daintree Road north of Wonga Beach, Sep 2002, *Jago 6297* (BRI); Mareeba, Jan 1918, *White s.n.* (BRI [AQ247418]). North Kennedy District: E of Mount Garnet, Feb 2008, *Wannan 4999* (BRI, NSW); Little Ramsay Bay, Hinchinbrook Island, Apr 2012, *Mathieson MTM1327* (BRI, NSW); Snake Creek, *c.* 95 km NW of Charters Towers on Gregory Developmental Road, Apr 1991, *Batianoff SC9104010* (BRI). South Kennedy District: Brampton Island near airstrip, Sep 1986, *Batianoff 5123* (AD, BRI); Black Wattle Creek Crossing, on Gregory Development Road, May 1991, *McFadyen 453* (BRI); Collinsville Coal Pty Ltd mine lease area, near Collinsville and Scottville, Apr 1984, *Thompson 587* (BRI). Leichhardt District: 8.8 km from Mt Dillingen peak and *c.* 87 km NNE of Clermont, Feb 1999, *Bailey LB65* (BRI); 45.8 km from Taroom, on road to Bauhinia Downs, May 2010, *Bean 29617* (BRI). Port Curtis District: 200m down road to St Lawrence from Bruce Highway, Jul 1998, *Thompson 1317* (BRI); Facing Island, Oct 2004, *c.* 0.7 km NW of Catcombe, *Halford Q8670* (BRI). Burnett District: About 3.3 km SE of Culcraigie along Culcraigie – Eidsvold Road, Apr 1997, *Pollock ABP391* (BRI); Toondahra HS yards, Jun 1989, *Forster PIF5076* (BRI, US). Wide Bay District: Near Maroondan, E of Gin Gin, Nov 1996, *Bean 11229* (BRI).

***Distribution and habitat*:** *Sphaeromorphaea subintegra* is recorded from southern lowland parts of Papua New Guinea, New Caledonia, and in Australia is widespread in eastern Queensland from the Torres Strait islands to Mundubbera (**Map 7**). It grows on wet or moist microhabitats in open forest and woodland dominated by *Eucalyptus* or *Melaleuca*, often on alluvium, but also on hillsides and plateaux. Soils vary from sand to reddish basaltic clay, and including soils derived from serpentinite. It has not been recorded from salt marsh communities.

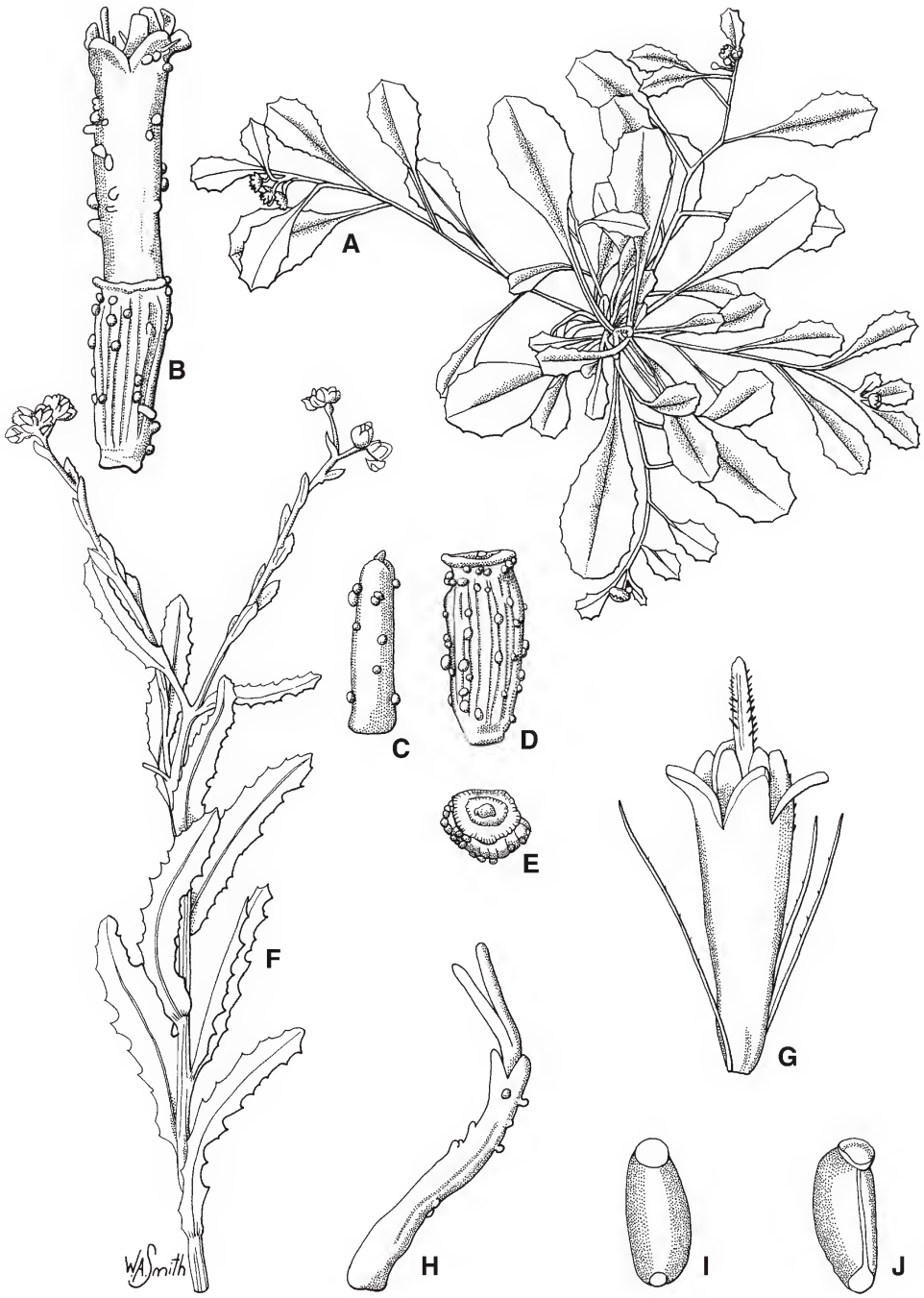

Fig. 4. **A–E**, ***Sphaeromorphaea subintegra***. A. Flowering plant ×0.6. B. disc floret and achene ×32. C. marginal floret ×32. D. achene, lateral view ×32. E. achene, plan view ×32. **F–J, *Ethuliopsis cunninghamii***. F. flowering branchlet ×1. G. disc floret ×16. H. marginal floret ×32. I. achene, abaxial view ×32. J. achene, adaxial view ×32. A, from *Bean 29617* (BRI); B–E from *McFadyen 453* (BRI); F, from *Cowan 81* (BRI); G, from *Mitchell 824* (BRI); H–J from *Emerson s.n.* (BRI [AQ501325]). Del. W.Smith.

***Phenology*:** Flowers and fruits can be found in any month of the year.

***Notes*:** *Sphaeromorphaea subintegra* differs from *S. australis* by the consistently small teeth on the leaves (no more than 0.5 mm long), the relatively broad and conspicuous coronal pappus, persistent hairs on mature leaves, and the marginal corolla conical in shape. Field observations and herbarium specimen labels suggest that where the distributions of this species and *S. australis* overlap, *S. subintegra* inhabits the more mesic sites (where fresh water is more readily available), whereas *S. australis* inhabits salt-affected sites, including salt marsh or headlands near the ocean, or sites that may dry out more quickly. No intergradation between these two species has been observed in the field or in the herbarium, even though they sometimes occur less than a kilometre from each other.

S. subintegra differs from *S. littoralis* by the lobing of the leaves (more conspicuously lobed in *S. littoralis*) and the very few twin hairs on the achene, if any (numerous twin hairs in *S. littoralis*).

The oldest herbarium specimen of *S. subintegra* that I have seen is one collected by Ernst Betche at Cooktown in 1881.

***Conservation status*:** A common and widespread species.

Ethuliopsis F.Muell., *Fragm.* 2: 154 (1861); *Epaltes* sect. *Ethuliopsis* (F.Muell.) F.Muell., *Fragm.* 10: 100 (1877). **Type:** *E. dioica* F.Muell. (= *E. cunninghamii*).

Gynaphanes Steetz in Peters, *Naturw. Reise Mossambique [Peters]* 6(2): 457 (1864). **Type:** *Gynaphanes australis* (= *Ethuliopsis cunninghamii*).

Perennial herbs. Latex absent. Stems terete, not winged. Leaves alternate, sessile, toothed, spreading, not decurrent. Capitula pedunculate, in terminal panicles; on some plants disciform and heterogamous; on other plants homogamous, with disc florets only. Involucral bracts variable in length, cartilaginous, in 3–6 rows. Receptacle glabrous, without paleae. Marginal florets fertile, female, without rays; corolla lobes 3, tiny; style base not bulbous, branches divergent. Disc florets bisexual, functionally male, ovary vestigial, not producing achenes. Anthers tailed, apically obtuse. Style base not bulbous, style undivided at apex; sweeping hairs obtuse, extending well down the shaft. Achenes lunate, with a single longitudinal rib on adaxial side; carpopodium annular, white, prominent. Pappus on the marginal florets comprising a persistent erect cylindrical corona; on the disc florets comprising 3–6 barbellate bristles.

A monotypic genus, endemic to Australia.

Ethuliopsis cunninghamii (Hook.) F.Muell., *Key to the System of Victorian Plants* 1: 313 (1888); *Ethulia cunninghamii* Hook. in T.Mitch., *J. Exped. Trop. Australia* 62 (1848); *Ethuliopsis dioica* F.Muell, *Fragm.* 2: 155 (1861), *nom. illeg.*; *Gynaphanes australis* Steetz in Peters, *Naturw. Reise Mossambique [Peters]* 6(2): 458 (1864), *nom. illeg.*; *Epaltes cunninghamii* (Hook.) Benth., *Fl. Austral.* 3: 530 (1867); *Erigerodes cunninghamii* (Hook.) O.Kuntze, *Revis. Gen. Pl.* 1: 335 (1891). **Type citation:** "We saw ... Also an ETHULIA, which may, on further examination, constitute a new genus; it was found by Allan Cunningham on the Lachlan." **Type:** Australia: New South Wales. Swampy banks of the Lachlan River, 26 June 1817, *A. Cunningham 290/1817* (lecto [here designated]: K 000373334; isolecto: G-DC).

***Illustrations*:** Cunningham *et al.* (2011: 685), as *Epaltes cunninghamii*.

Erect herb, to 100 cm high. Stems glabrous. Leaves oblong to oblanceolate, 20–69 × 4.5–17 mm, 3.6–8.5 times longer than broad, bright green, concolorous, resin globules sometimes present on lower surface; glabrous or with sparse multicellular hairs; margins denticulate to dentate with 5–13 pairs of teeth each 0.3–3 mm long; apex obtuse or acute; base cuneate to obtuse. Capitula in small terminal panicles. Peduncles 0–4.5 mm long, glabrous or sparsely glandular-hairy. *Homogamous capitula*: Capitula cylindrical to campanulate at anthesis, 3.5–5 mm long, 2.5–5.5 mm wide. Involucral bracts flat,

glabrous, outer ones much shorter than inner; median involucral bracts 3.1–3.5 × 0.6–1.1 mm, apex obtuse, margin entire. Receptacle flat. Marginal florets absent; disc florets 20–35, bisexual; corolla narrowly campanulate, 2–3.1 mm long, 0.2–0.3 mm wide near base, 0.5–1 mm wide near apex, white, resin globules present throughout; lobes 5, 0.25–0.3 mm long; style undivided; ovary vestigial; pappus bristles 2–6, 1.9–2.6 mm long, barbellate, slightly flattened, often bent or twisted near apex. *Heterogamous capitula*: Capitula globose at anthesis, 2.5–3 mm long, 2.5–3 mm wide. Involucral bracts incurved, glabrous; outer ones much shorter than inner; median bracts 2–2.7 × 1–1.2 mm, apex obtuse, glabrous, margin entire or denticulate. Receptacle hemispherical. Marginal florets 100–200, in several rows, female; corolla filiform, 0.8–1.3 mm long, white, cylindrical, multicellular hairs absent, few to numerous resin globules present; lobes 3, tiny; styles slender, branched. Disc florets 2–16, bisexual; corolla narrowly campanulate, 1.2–1.5 mm long, 0.2–0.3 mm wide near base, *c.* 0.5 mm wide near apex, white, resin globules present throughout; lobes 5, 0.25–0.3 mm long; style undivided; ovary vestigial; pappus bristles 2–6, 0.8–1.1 mm long, barbellate, slightly flattened, often bent or twisted near apex. Achenes formed only from marginal florets, lunate, 0.6–0.7 mm long, *c.* 0.2 mm wide, with 1 conspicuous longitudinal rib, and several raised anastomosing veins sometimes visible; twin hairs absent; resin globules absent. Pappus corona obliquely placed, erect, cylindrical, white, 0.03–0.05 mm high, margin entire; pappus bristles absent. **Fig. 4F-J.**

***Additional selected specimens examined*: Australia: South Australia.** Katarapko Reserve, N of Loxton, Jul 1985, *Alcock 10249* (AD, MEL, NSW, NY); 7 km W of Mundondna HS, May 1984, *Badman 1022* (AD, CANB, MEL, NSW); Waukatanna waterhole, Cooper Creek, Apr 1985, *Badman 1646* (AD, BRI, MEL); 50 km SE of Coongie, Lake Eyre basin, Oct 1986, *Conrick 1939* (AD, BRI, NSW); Pandiburra Bore, Aug 1975, *Donner 5177* (AD, US); Neals River, 56 km S of Oodnadatta on track to William Creek, Nov 1989, *Nordenstam & Anderberg 972* (AD, MEL, NSW, PERTH); Engenina Creek, on the Coober Pedy – William Creek Road, Sep 1990, *Wilson 789 & Rowe* (AD, MEL, NSW). **Queensland.** Gregory North District: Cuttaburra Channels, Eyre Development Road, S of Bedourie, May 2007, *Bean 26385* (BRI, MEL); 116 km N of Birdsville, Sep 1989, *Cowan 81 & Bushell* (BRI). Warrego District: *c.* 15 km W of Quilpie, Nov 1975, *Henderson H2384* (BRI). Gregory South District: Thylungra, *c.* 75 miles [*c.* 121 km] NW of Quilpie, Oct 1955, *Everist 5768* (BRI); 1.3 km S of Plevna Downs HS gate, W of Eromanga, Aug 2010, *Bean 30103* (BRI); Lake Yamma Yamma, Sep 1991, *Mitchell 824* (BRI); Windorah, 'Tanbar', Cooper Creek, Nov 1990, *Emerson s.n.* (BRI [AQ 501325]). **New South Wales.** Yantara Lake, Oct 1887, *Baeuerlen s.n.* (NSW); 15.1 km SW of Goodooga, Dec 1998, *Bean 14508* (BRI, NSW); Near Barrier Range, Feb 1861, *Beckler s.n.* (MEL); Delalah Downs, Aug 1972, *Cunningham 476* (BRI, NSW); Willandra Creek, *c.* 28 miles [*c.* 43 km] SE of Ivanhoe, Nov 1973, *Salasoo 5427* (NSW). **Victoria.** Kings Billabong Wildlife Reserve, near Red Cliffs, Aug 1975, *Beauglehole 50256* (AD, MEL); Kings Billabong, Red Cliffs area, May 1969, *Henshall s.n.* (MEL); W of Neds Corner HS, Mullaroo Creek, 5.5 km due N of Lake Wallawalla, Lindsay Island, Dec 1981, *Browne 73* (MEL); Lake Lalbert, Dec 1853, *Mueller s.n.* (MEL).

***Distribution and habitat*:** *Ethuliopsis cunninghamii* is widely distributed in south-western Queensland, western New South Wales, eastern South Australia and north-western Victoria (**Map 8**), in areas that receive less than about 600 mm annual rainfall. It grows in heavy clay soil on alluvial flats, and around ephemeral swamps and lakes. Associated species include lignum (*Muehlenbeckia florulenta* Meisn.), gidgee (*Acacia cambagei* R.T.Baker), coolabah (*Eucalyptus coolabah* Blakely & Jacobs), and bluebush (*Chenopodium auricomum* Lindl.).

***Phenology*:** Flowers and fruits have been recorded from March to December, but flowering and fruiting is most likely synchronised to rainfall events rather than season.

***Notes*:** *Ethuliopsis* is distinct from both *Epaltes sens. str.* (*E. divaricata*) and from *Sphaeromorphaea*, and would appear to be more closely related to some members of the large genus *Pluchea*. The latter is a very complex and possibly paraphyletic assemblage (Anderberg *et al.* 2005), and none of the *Pluchea* species in Australia or south-east Asia have characters similar to those exhibited by *Ethuliopsis*.

Ethuliopsis cunninghamii is sub-dioecious. Some plants have homogamous capitula that bear only disc florets. These florets are bisexual, but do not produce

achenes and the ovary is vestigial, hence they are effectively male. The capitula on these plants are campanulate or cylindrical, the median involucral bracts are 3.1–3.5 mm long, and the corolla of the disc florets is 2–3.1 mm long. Other plants have heterogamous capitula that bear predominantly marginal florets, with a few disc florets in the centre. The capitula on those plants are globose, the median involucral bracts are 2–2.7 mm long, and the corolla of the disc florets is 1.2–1.5 mm long. Hence, specimens of the "male" and "female" plants can be readily distinguished by capitulum shape and size, or by floret size. The corolla of both marginal and disc florets is white, unlike *Sphaeromorphaea* spp. (except marginal florets of *S. major*) and *Epaltes divaricata* which are pink to purple.

There is one herbarium specimen reportedly collected from the Northern Territory. It is at MEL, and has a handwritten label written in ink stating "118. Epaltes cunninghamii B., 1885/6, Lieut. Dittrich, Lindsay's Exped." Someone else has later written, in pencil, "finke river". As this species has never otherwise been recorded from the Northern Territory, it seems likely that the locality is in error, and that the specimen was in fact collected in South Australia.

***Conservation status*:** A common and widespread species.

Key to the Australian genera of Subtribe *Plucheinae*

1 Capitula grouped into secondary heads or glomerules **2**
1. Capitula all separate **3**

2 Pappus absent . . . . . **Sphaeranthus**
2. Pappus present . . . . . **Pterocaulon**

3 Pappus of the marginal florets consisting of a small corona, sometimes with 1–5 bristles arising from it **4**
3. Pappus of all florets with 10 or more bristles, corona absent **5**

4 Achenes cylindrical, with 5–14 longitudinal ribs; capitula all heterogamous, hemispherical to oblate; corolla pink to purple, rarely white . . . . . **Sphaeromorphaea**
4. Achenes lunate, with 1 longitudinal rib; capitula heterogamous or homogamous, campanulate or globose; corolla white . . . . . **Ethuliopsis**

5 Pappus bristles fused into a tube at their base . . . . . **Coleocoma**
5. Pappus bristles all free **6**

6 Pappus bristles broad-based, persistent, ebarbellate . . . . . **Thespidium**
6. Pappus bristles slender throughout, somewhat caducous, barbellate **7**

7 Disc florets 3-merous; anthers not tailed . . . . . **Allopterigeron**
7. Disc florets 4-merous or 5-merous; anthers tailed **8**

8 Corolla of marginal florets irregularly lobed to distinctly ligulate; achenes densely sericeous . . . . . **Streptoglossa**
8. Corolla lobes of marginal florets equal; achenes glabrous or sparsely hairy . . . . . **Pluchea**

Excluded names in *Epaltes* and *Sphaeromorphaea*

Epaltes alata (Sond.) Steetz in Peters, *Naturw. Reise Mossambique [Peters]* 6(Bot., 2): 452 (1864) = **Litogyne gariepina** (DC.) Anderb.

Epaltes gariepina (DC.) Steetz in Peters, *Naturw. Reise Mossambique [Peters]* 6(Bot., 2): 451 (1864) = **Litogyne gariepina** (DC.) Anderb.

Epaltes pleiochaeta F.Muell., *Fragm.* 10: 100 (1877) = **Pluchea baccharoides** (F.Muell.) Benth.

Epaltes tatei F.Muell., *Trans. & Proc. Roy. Soc. South Australia* 6: 31 (1883) = **Haegiela tatei** (F.Muell.) P.S.Short & Paul G.Wilson.

Sphaeromorphaea centipeda DC., *Prodr.* 6: 140 (1838). An illegitimate name based on *Artemisia minima* L. (= **Centipeda minima**).

Centipeda sect. *Sphaeromorphaea* C.B.Clarke, *Compos. Ind.* 151 (1876) is typified by *Centipeda orbicularis nom. illeg.* (= **Centipeda minima**). This sectional name is therefore a synonym of *Centipeda.*

Sphaeromorphaea russeliana var. *glabrata* DC., *Prodr.* 6: 140 (1838). **Type:** NW India, J.F. Royle *s.n.* (syn: K 000373336, image!) = **Centipeda minima** subsp. **minima**. A Royle specimen at G-DC [G00318749] identified as var. *glabrata* is evidently from a different gathering. It bears the number 260, and the locality Cachemire [?], rather than the 'prov. bor.-occid.' as stated in the protologue. This latter specimen is not considered a type. It represents *Sphaeromorphaea littoralis.*

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References

Anderberg, A.A. (1991). Taxonomy and phylogeny of the tribe Plucheeae (Asteraceae). *Plant Systematics and Evolution* 176: 145–177.

Anderberg, A.A., Eldenas, P., Bayer, R.J. & Englund, M. (2005). Evolutionary relationships in the Asteraceae tribe Inuleae (incl. Plucheeae) evidenced by DNA sequences of ndhF; with notes on the systematic positions of some aberrant genera. *Organisms, Diversity & Evolution* 5: 135–146.

Anderberg, A.A. & Eldenas, P. (2007). Tribe Inuleae. In: K. Kubitzki (ed.), *The Families and Genera of Vascular Plants*, Volume VIII, *Asterales.* Springer: Berlin, Heidelberg, New York.

Apc (2012). *Australian Plant Census.* IBIS database, Centre for Australian National Biodiversity Research, Council of Heads of Australasian Herbaria. http://www.chah.gov.au/apc/index.html Accessed 16 December 2012.

Bailey, F.M. (1900). *The Queensland Flora*, Part III. J. Diddams & Co.: Brisbane.

Beentje, H.J. (2002). *Flora of Tropical East Africa*, Compositae Part 2. Royal Botanic Gardens: Kew.

Bentham, G. (1867). Compositae. In *Flora Australiensis* 3: 447–680. L.Reeve & Co.: London.

—— (1873). Compositae. In G. Bentham & J.D. Hooker, *Genera Plantarum* 2(1): 163–537. L.Reeve & Co.: London.

Bremer, K. (1994). *Asteraceae: Cladistics and Classification.* Timber Press: Portland, Oregon.

Britten, J. (1901). *Illustrations of Australian plants collected in 1770 during Captain Cook's voyage round the world in H.M.S. Endeavour /by the Right Hon. Sir Joseph Banks and Daniel Solander, with determinations by James Britten. Australian Plants, Part II.* Trustees of the British Museum: London.

Brummitt, R.K. (2001). *World Geographical Scheme for recording Plant Distributions, Edition 2.* International Working Group on Taxonomic Databases for Plant Sciences: Pittsburgh. http://www.tdwg.org/standards/109 Accessed 29 December 2012.

Cassini, H. (1818). Aperçu des genres nouveaux formés par M. Henri Cassini dans la famille des Synanthérées. *Bulletin des Sciences, par la société Philomatique de Paris* 1818: 139–142.

Cooke, D.A. (1986). Compositae (Asteraceae). In J.P. Jessop & H.R. Toelken (eds.), *Flora of South Australia, Pt. III. Polemoniaceae – Compositae*, pp. 1423–1658. South Australian Goverment. Printing Division: Adelaide.

Cunningham, G.M., Mulham, W.E., Milthorpe, P.L. & Leigh, J.H. (2011). *Plants of Western New South Wales*, 2nd edition. CSIRO Publishing: Collingwood, Victoria.

De Candolle, A.P. (1836). *Prodromus systematis naturalis regni vegetabilis* 5:461–462. Treuttel & Wurtz: Paris

—— (1838). *Prodromus systematis naturalis regni vegetabilis* 6: 140. Treuttel & Wurtz: Paris

Dunlop, C.R. (2000). Asteraceae. In I.D. Cowie, P.S. Short & M. Osterkamp Madsen (eds.), *Floodplain Flora – A flora of the coastal floodplains of the Northern Territory, Australia,* pp. 180–189. Flora of Australian Supplementary series No. 10. Australian Biological Resources Study: Canberra.

Figuerola, J. & Green, A.J. (2002). Dispersal of aquatic organisms by waterbirds: a review of past research and priorities for future studies. *Freshwater Biology* 47: 483–494.

Fontaine, B., Perrard, A. & Bouchet, P. (2012). 21 years of shelf life between discovery and description of new species. *Current Biology* 22: 943–944.

Fosberg, F.R. & Sachet, M.-H. (1980). *Flora of Micronesia, 4: Caprifoliaceae to Compositae. Smithsonian Contributions to Botany*, Number 46. Smithsonian Institution Press: Washington.

Gagnepain, F. (1924). In H. Lecomte (ed), *Flore générale de l'Indo Chine* 3(5): 557–664. Masson & Co.: Paris.

Grin (2012). USDA, ARS, National Genetic Resources Program. Germplasm Resources Information Network - (GRIN) [Online Database]. Accessed 29 January 2012.

Hawgood, B.J. (1994). The life and viper of Dr Patrick Russell MD FRS (1727–1805): Physician and Naturalist. *Toxicon* 32: 1295–1304.

Heywood, V.H. & Humphries, C.J. (1977). Anthemideae – systematic review. In V.H. Heywood *et al.* (eds.), *The Biology and Chemistry of the Compositae* 2: 851–898. Academic Press: London.

Hiepko, P. (1987). The collections of the Botanical Museum Berlin-Dahlem (B) and their history. *Englera* 7: 219–552.

Hooker, J.D. (1882). Compositae. In *The Flora of British India* 3: 219–419. L. Reeve & Co.: London.

Hooker, W.J. (1831). In R. Wight, Illustrations of Indian Botany, principally of the southern parts of the peninsula. *Botanical Miscellany, London* 2: 90–97.

Hu, S. & Wong, Y. (2009). Asteraceae. In *Flora of Hong Kong* 3: 245–328. Government of the Hong Kong Special Administrative Region: Hong Kong.

Huh (2012) *Index of Botanists*. Harvard University Herbaria. http://kiki.huh.harvard.edu/databases/botanist_index.html Accessed 10 October 2012.

Iucn (2001). *Red List Categories and Criteria: Version 3.1.* IUCN Species Survival commission. IUCN, Gland, Switzerland and Cambridge, U.K.

Leins, P. (1971). Pollensystematische Studien an Inuleen I. *Botanische Jahrbücher für Systematik, Pflanzengeschichte und Pflanzengeographie* 91: 91–146.

Lessing, C.F. (1830). De Synanthereis Herbarii Regii Berolinensis, dissertatio secunda: Nassauvieae. *Linnaea* 5: 1–236.

—— (1832). *Synopsis Generum Compositarum earumque dispositionis novae tentamen monographiis multarum capensium interjectis.* Dunckeri & Humblotii: Berlin.

Li, H. (1978). Compositae. In *Flora of Taiwan* 4: 768–965. Epoch Publishing Co., Ltd: Taipei.

Logan River Branch Sgap (2005). *Mangrove to Mountains, a field guide to the native plants of south-east Queensland*, Volume 2. Logan River Branch SGAP: Browns Plains.

Lowndes, W.T. (1834). *A bibliographer's manual of English literature*, Volume 3. William Pickering: London.

Merrill, E.D. & Rolfe, R.A. (1908). Notes on Philippine Botany. *The Philippine Journal of Science* 3: 95–127.

Merxmueller, H., Leins, P. & Roessler, H. (1978). 'Inuleae - systematic review'. In V.H. Heywood *et al.* (eds.), *The Biology and Chemistry of the Compositae*, pp. 577–602. Academic Press: London, New York, San Francisco.

Moore, C. & Betche, E. (1893). *Handbook of the Flora of New South Wales.* Government Printer: Sydney.

Mueller, F. (1861). *Ethuliopsis. Fragmenta Phytographiae Australiae* 2(16): 154. Government Printer: Melbourne.

Mukherjee, S.K. & Sarkar, A.K. (2001). Morphological diversity of pappus in the subfamily Asteroideae (Asteraceae). In J.K. Maheshwari (ed.), *Recent Researches in Plant Anatomy and Morphology*, pp. 275–294. Scientific Publishers: Jodhpur, India.

Naithani, B.D. (1995). Tribe Anthemideae. In *Flora of India* 12: 3–75. Botanical Survey of India: Calcutta.

National Library Of Australia (2009-onwards). TROVE. http://trove.nla.gov.au/ Accessed November 2012.

Peng, C. (2004). Digital Flora of Taiwan. http://www.efloras.org/flora_page.aspx?flora_id=100 Accessed 29 January 2012.

Retief, E. & Herman, P.P.J. (1997). Plants of the northern provinces of South Africa: keys and diagnostic characters. *Strelitzia* 6: 1–681.

Short, P.S. & Wilson, P.G. (1990). *Haegiela*, a new genus of Australian Asteraceae (Inuleae: Gnaphaliinae), with notes on the genus *Epaltes* Cass. *Muelleria* 7: 259–265.

Short, P.S., Albrecht, D.E., Cowie, I.D., Lewis, D.L. & Stuckey, B.M. (2011). *Checklist of the Vascular Plants of the Northern Territory, May 2011.* Northern Territory Herbarium: Department of Natural Resources, Environment, The Arts and Sport. http://www.nt.gov.au/nreta/wildlife/plants_herbarium/pdf/200701nt_checklist.pdf Accessed 3 March 2012.

Sonder, O.W. (1853). Compositae. In Plantae Muellerianae, Beitrag zur Flora Südaustraliens, aus den Sammlungen des Dr. Ferd. Müller. *Linnaea* 25: 450–656.

Soons, M.B., Vlugt, C. Van Der, Lith, B. Van, Heil, G.W. & Klaassen, M. (2008). Small seed size increases the potential for dispersal of wetland plants by ducks. *Journal of Ecology* 96: 619–627.

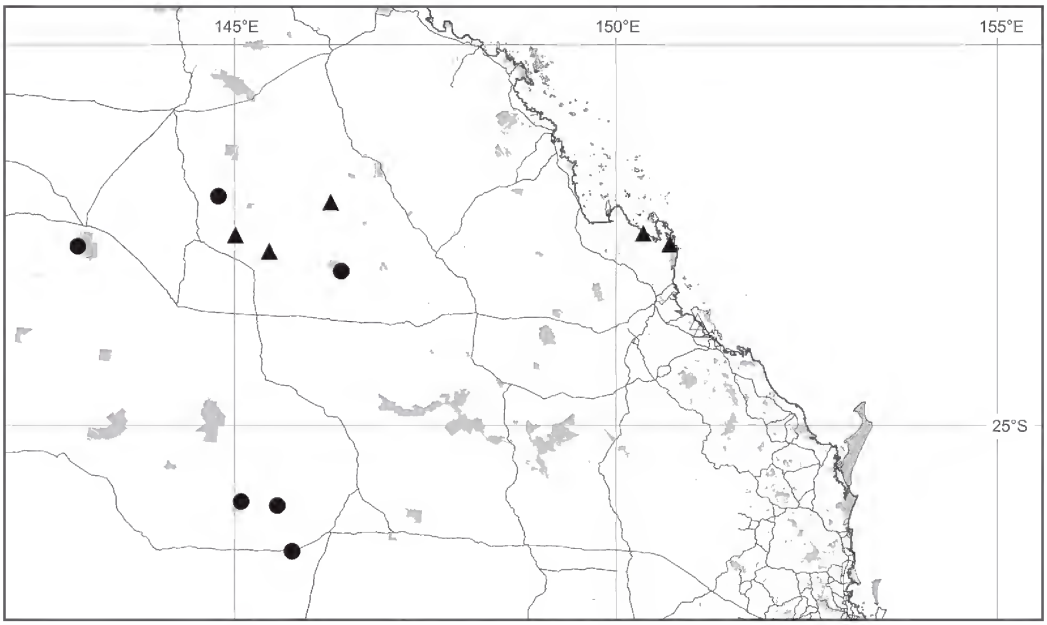
Stephens, K. & Sharp, D. (2009). *Flora of North Stradbroke Island.* Queensland Herbarium: Brisbane.

Vallance, T.G., Moore, D.T. & Groves, E.W. (2001). *Nature's Investigator, The Diary of Robert Brown in Australia.* Australian Biological Resources Study: Canberra.

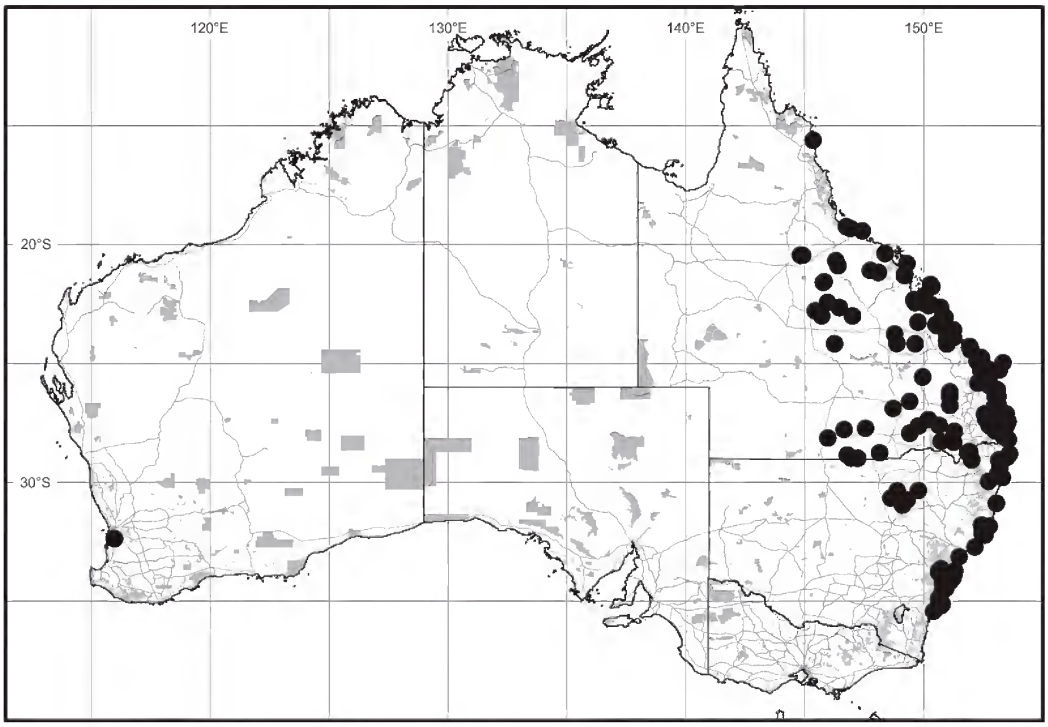
Wallich, N. (1831). *Numerical List of Dried Specimens of plants in the Museum of the Honl. East India Company*, numbers 2604–4877. East India Company: London.

Walsh, N.G. (2001). A revision of *Centipeda* (Asteraceae). *Muelleria* 15: 33–64.

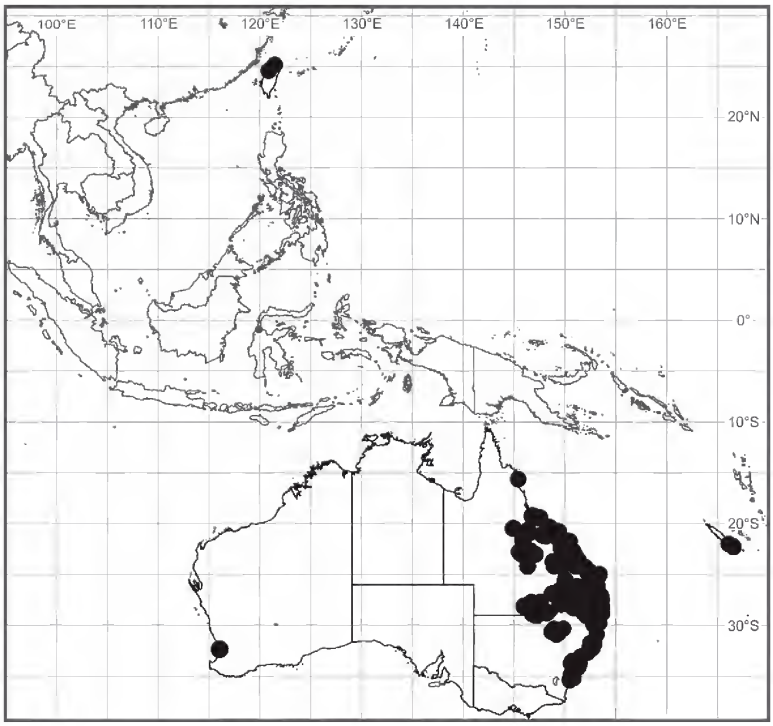
Walsh, N.G. & Stajsic, V. (2007). *A Census of the Vascular Plants of Victoria*, 8th edition. Royal Botanic Gardens, Melbourne. http://www.rbg.vic.gov.au/viclist/ Accessed 3 March 2012.



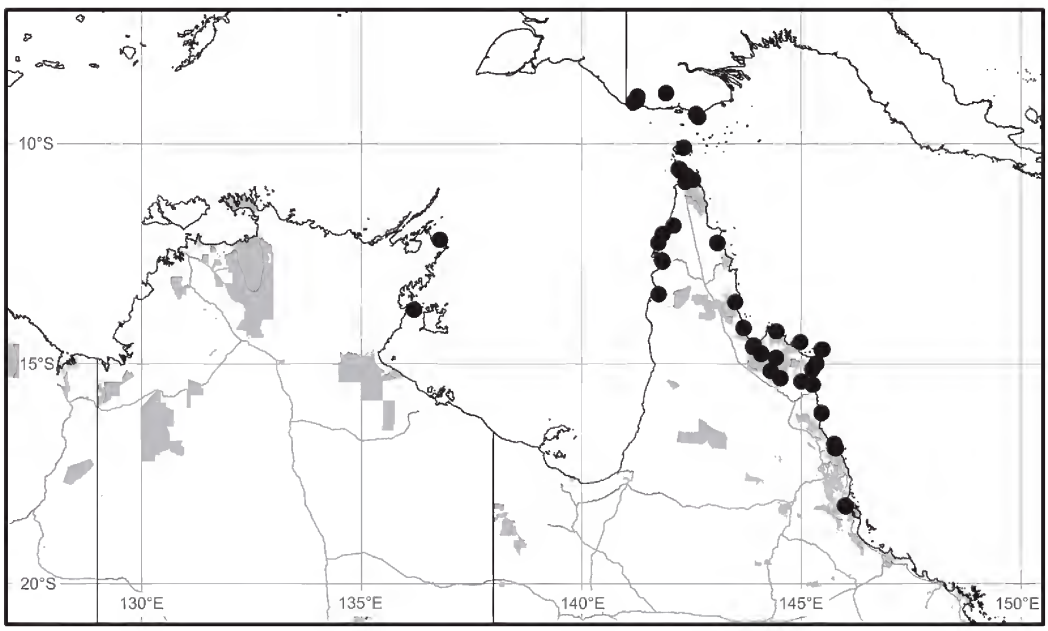
Map 1. Distribution of *Sphaeromorphaea ephemera* (circle) and *S. major* (triangle).



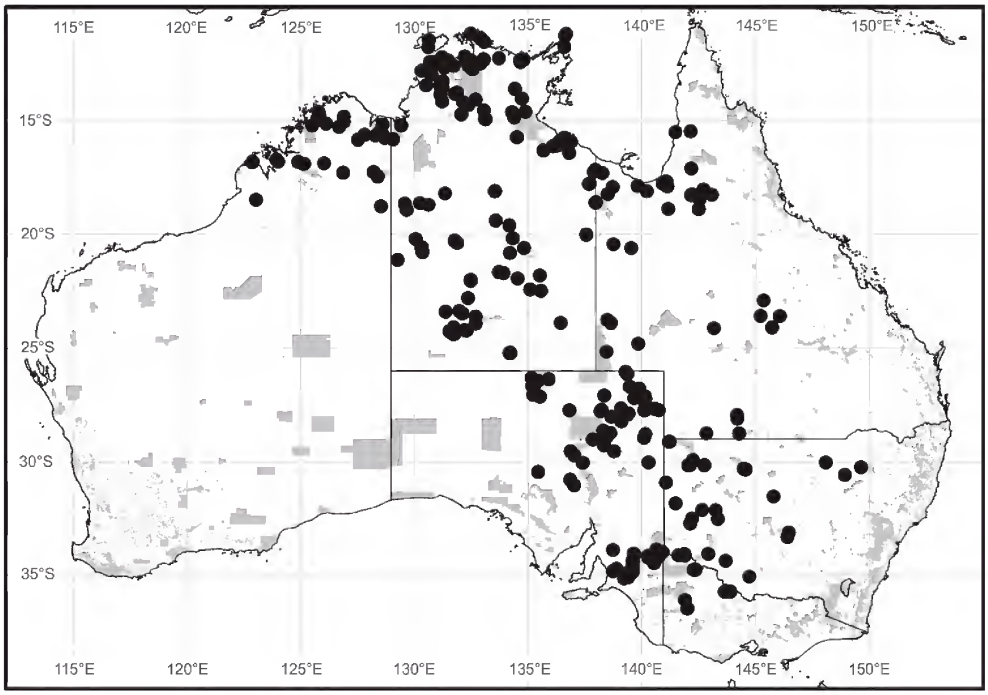
Map 2. Australian distribution (native and naturalised) of *Sphaeromorphaea australis*.



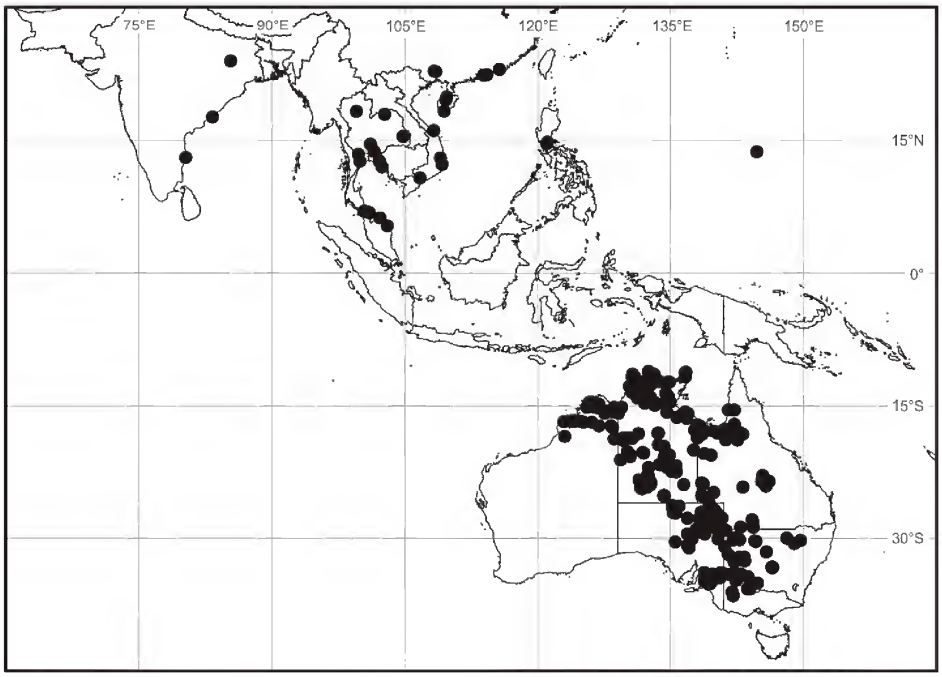
Map 3. World distribution (native and naturalised) of *Sphaeromorphaea australis*.



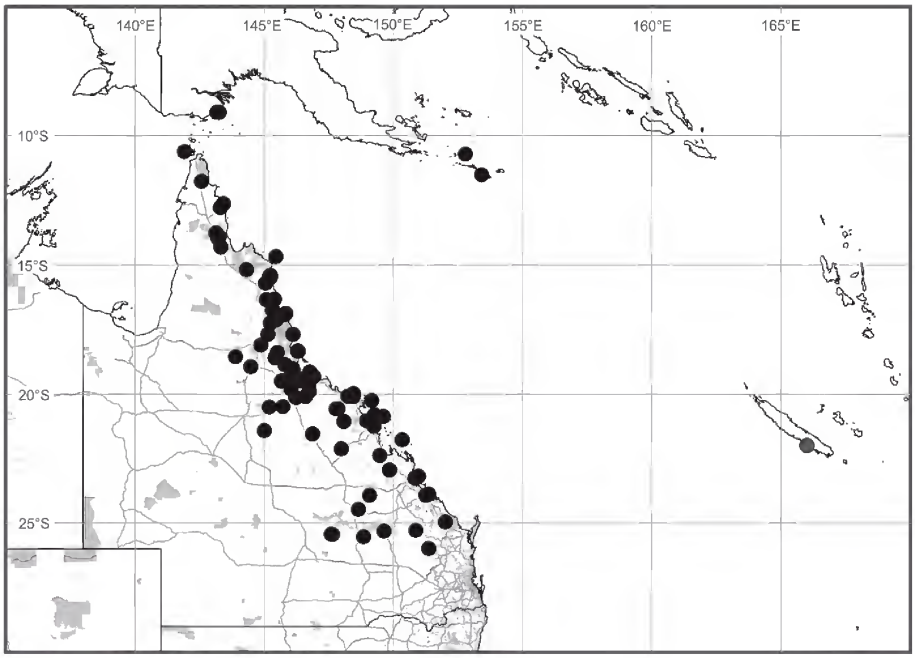
Map 4. World distribution of *Sphaeromorphaea harrisii*.



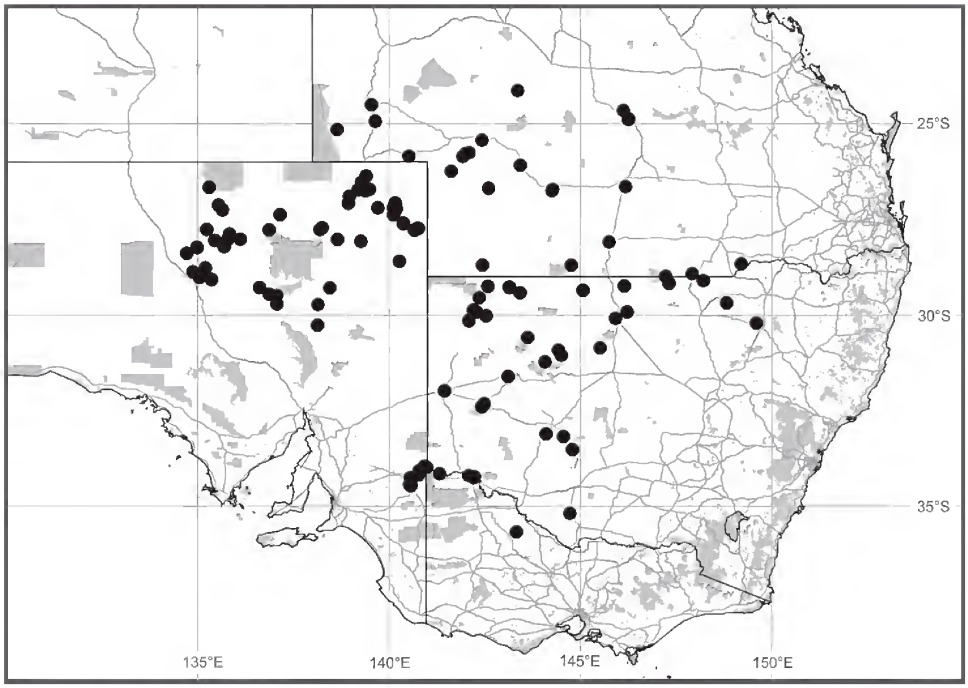
Map 5. Australian distribution of *Sphaeromorphaea littoralis*.



Map 6. World distribution (native and naturalised) of *Sphaeromorphaea littoralis*.



Map 7. World distribution of *Sphaeromorphaea subintegra.*



Map 8. Distribution of *Ethuliopsis cunninghamii.*

Reinstatement of intraspecific taxa for *Bosistoa pentacocca* (F.Muell.) Baill. (Rutaceae) with a new combination *B. pentacocca* subsp. *connaricarpa* (Domin) P.I.Forst.

Paul I. Forster

Summary

Forster, P.I. (2013). Reinstatement of intraspecific taxa for *Bosistoa pentacocca* (F.Muell.) Baill. (Rutaceae) with a new combination *B. pentacocca* subsp. *connaricarpa* (Domin) P.I.Forst. ***Austrobaileya* 9(1): 60–65.** Geographic variation in morphology of *Bosistoa pentacocca* is discussed and the recognition of subspecies is proposed with the new combination *B. pentacocca* subsp. *connaricarpa* (Domin) P.I.Forst. Typification of the name *Bosistoa connaricarpa* Domin is reviewed with the holotype designated as being at K.

Key Words: Rutaceae, *Bosistoa*, *Bosistoa pentacocca* subsp. *connaricarpa*, Australia flora, Queensland flora, identification key, taxonomy, subspecies, John Dallachy

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Introduction

Bosistoa pentacocca (F.Muell.) Baill. as defined by Hartley (2013), is a variable species from eastern Australia with numerous geographically discrete population centres (**Map 1**). This revised his initial analysis of these same populations as comprising one species with three varieties, with each variety based on discrete population centres and defined on leaf morphology (Hartley 1977). In this instance Hartley's use of variety was equivalent to that of subspecies (*sensu* Forster 2005; Duretto & Forster 2007) wherein the relevant taxon is confined to a discrete geographic region and is morphologically distinct. Hartley's (2013) more conservative taxonomic conclusion was based on the greater number of collections now available and that the previously perceived differences between taxa were no longer valid. Diverse chemical evidence also tends to support a single species, albeit with some variation between populations (Auzi *et al.* 1997; Brophy *et al.* 2007), although both these studies sampled only a small number of populations.

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Notwithstanding Hartley's (2013) conclusion, there remain clear morphological differences between the most southern and the other population centres, principally the number of leaflets in each leaf and the number of secondary (lateral) veins per side of the primary (midrib) vein in each leaflet. These differences are easily discernible both in the field and on herbarium material and persist in material of known origin cultivated in a common garden. Although occasional collections exhibit divergence towards the other morphotype, the overall differences are consistent within a given geographic area (**Map 1**). My conclusion is that two intraspecific taxa can still be recognised within *Bosistoa pentacocca* (maintaining the *status quo* of Forster 1997, 2002, 2007, 2010; Harden *et al.* 2006); however, I prefer the rank of subspecies rather than variety as the latter taxonomic category is more suited to within population variation. The existence of some populations (see below) exhibiting intermediate combinations of characters are to be expected and demonstrate continuity as required by Stebbins (1950), viz. "subspecies....connected....by a series of intergrading forms".

If a metapopulation concept (Hanski & Gilpin 1991; Freckleton & Watkinson 2002) is applied to *Bosistoa pentacocca* then it can be hypothesised that the species consists of at least six, geographically discrete, metapopulations with *B. pentacocca* subsp. *pentacocca* existing as a single metapopulation (1 on **Map 1**). Each of the metapopulations comprise few to many populations or subpopulations in 'core', possibly refugial areas, with occasional outlying populations/subpopulations. Applying this hypothesis, the 'core' area for *B. pentacocca* subsp. *pentacocca* exists within the Border Ranges (McPherson/Macleay overlap) centre of plant species richness and endemism of southeast Queensland and northeast New South with a concentration of populations on the basalt flows associated with the Mt Warning caldera and an 'outlier' population at Mt French, Boonah. Five metapopulations can be hypothesised for *B. pentacocca* subsp. *connaricarpa* (*viz.* 2. Mt Dryander – Conway Range area; 3. Eungella – Kuttabul area; 4: Rockhampton area; 5. Bulburin – Miriam Vale area; 6. Mt Urah – Cold Creek area (**Map 1**). These proposed metapopulations remain to be tested using molecular data, although it is perhaps likely that most are refugial in a genetic sense (i.e. with little existence of active gene flow apart from within catchments).

Materials and methods

Populations of *Bosistoa pentacocca* throughout its known range in Queensland were examined in the field. Herbarium collections at BRI and CANB were reviewed, plus online or scanned images of selected specimens at K and MEL.

Common abbreviations in the specimen citation text include NP (National Park), SF (State Forest) and TR (Timber Reserve).

Taxonomy

Bosistoa pentacocca (F.Muell.) Baill., *Hist. Pl.* 4: 470 (1873); *Euodia pentacocca* F.Muell., *Fragm.* 3: 41 (1862); *B. sapindiformis* F.Muell. ex Benth., *Fl. Austral.* 1: 359 (1863), *nom. illeg.*; *Acradenia bosistoi* F.Muell., *Pap. & Proc. Roy. Soc. Tasmania* 8: 8 (1868) & *Fragm.* 6 167 (1868), *nom. illeg.* **Type:** New South Wales. Clarence River, *s.dat.*, *H. Beckler s.n.* (holo: MEL 67499, online image!; iso: K 000717477, online image!, P 04355028, online image!).

The species description is as per Hartley (2013) and two subspecies are recognised here. The specimens cited are representative of the six proposed metapopulations (numbered as above).

Key to the subspecies of *Bosistoa pentacocca*

1 Leaves with 3–5(–6) leaflet pairs; leaflets with 16–30 secondary (lateral) veins per side of primary (midrib) vein. . . . . **B. pentacocca** subsp. **pentacocca**

1. Leaves with 1 or 2 (rarely 3) leaflet pairs; leaflets with 13–16(–18) secondary (lateral) veins per side of primary (midrib) vein . . . . . **B. pentacocca** subsp. **connaricarpa**

Bosistoa pentacocca subsp. **pentacocca**
B. pentacocca var. *pentacocca* Hartley, *J. Arnold Arbor.* 58: 423 (1977).

Leaves imparipinnate, 14–45 cm long, with 3–5 (rarely 6) leaflet pairs; terminal leaflet usually oblanceolate, more rarely elliptic-oblong, subterminal leaflets oblanceolate, elliptic-oblong to narrowly elliptic, margins of all leaflets crenate to coarsely serrate, rarely entire, with 16–30 secondary (lateral) veins per side of primary (midrib) vein.

***Selected specimens examined*: Queensland.** MORETON DISTRICT: Ormeau, corner of Barrenjoey & Upper Ormeau Roads, Jan 1995, *Forster PIF16086 & Leiper* (BRI); NW slopes of Mt French, Apr 1982, *Bird s.n.* (BRI [AQ339215]); Mt French, NW slopes, 7.8 km WNW of Boonah, Jan 1983, *Guymer 1847A & Jessup* (BRI, CANB, MEL, NSW); Tambourine Mt, in Guanaba Gorge, Mar 1947, *Blake 17387* (BRI); Numinbah Forest Reserve, *c.* 15 km SW of Nerang, southern slope of Pages Pinnacle, Jan 2006, *Halford Q8958* (BRI); Upper Currumbin Creek, Tomewin Range, Oct 1981, *Williams 81250* (BRI); Nicholl Scrub NP, Currumbin Valley, Feb 2011, *Forster PIF37846 & Fernando* (BISH, BRI, MEL); Egg Rock/Prison Farm track Nixons Creek, Lamington

NP, Nov 1993, *Grimshaw G168* (BRI); Cave Creek, Natural Bridge [Springbrook] NP, Numinbah Valley, Mar 1978, *Field s.n.* (BRI [AQ264150]. **New South Wales.** North Coast: Booyong Recreation Reserve, Big Scrub Remnant, Feb 1987, *Floyd s.n.* (BRI [AQ495572]).

***Distribution and habitat*:** *Bosistoa pentacocca* subsp. *pentacocca* is endemic to southeast Queensland (northern limit at Ormeau) and northeast New South Wales (south to the Clarence River) (**Map 1**). A western, outlying population occurs at Mt French, Boonah. It is found in rainforest (araucarian notophyll to microphyll vineforest) on diverse substrates (basalts, metasediments) predominantly on alluvium and colluvium along ephemeral watercourses.

***Notes*:** The most commonly encountered morphological state for this subspecies has plants with leaves with 4 or 5 leaflet pairs and predominantly oblanceolate leaflets that are always toothed. Occasionally the leaflets are more or less entire, but they are usually mixed in with toothed leaflets on the same branch. Fertile branchlets generally have leaflets at the larger end of the recorded dimensions whereas in *Bosistoa pentacocca* subsp. *connaricarpa*, the leaflets are usually much smaller and tend to be elliptic in shape.

Bosistoa pentacocca subsp. **connaricarpa** (Domin) P.I.Forst., **comb. et stat. nov.**; *B. connaricarpa* Domin, *Feddes Repert. Spec. Nov. Regni Veg.* 12: 390 (1913); *B. pentacocca* var. *connaricarpa* (Domin) T.G.Hartley, *J. Arnold Arbor.* 58: 424 (1977). **Type citation:** "Queensland: Rockhampton, leg. Dallachy". **Type:** Queensland. Port Curtis District: Rockhampton, 12 December [1862], [*J. Dallachy s.n.*] (holo: K, image!).

Bosistoa pentacocca var. *dryanderensis* T.G.Hartley, *J. Arnold Arbor.* 58: 425 (1977). **Type:** Queensland. North Kennedy District: Mt Dryander, 11 August 1972, *V.K. Moriarty 968* (holo: CANB; iso: BRI).

Leaves imparipinnate or pinnately trifoliate, 9–30 cm long, with 1 or 2, rarely 3 leaflet pairs; terminal leaflet usually elliptic, subterminal leaflets oblanceolate to elliptic or narrowly elliptic, margins of all leaflets entire, or crenate to coarsely serrate, with 13–16(–18) secondary (lateral) veins per side of primary (midrib) vein.

***Additional selected specimens examined*: Queensland.** North Kennedy District: [2*]Portello's Crossing, Dryander Creek, base of Mt Dryander, Feb 1994, *Forster PIF14859 & Bean* (A, BRI, CNS, MEL); [2]Sawmill Beach, Whitsunday Island [Whitsunday Islands NP], Sep 1990, *Batianoff 9009838 & Batianoff* (BRI; BISH, LAE *n.v.*); [2]Impulse Creek, SF299 Conway, May 1991, *Forster PIF8300 & McDonald* (BRI, CNS, K, MEL). South Kennedy District: [3]Mt Blackwood, S side *c.* 5 km from Kuttabul, Jun 1984, *Champion 68* (BRI); [3]Mt Adder, southern base, Mount Jukes NP, Apr 1991, *Forster PIF8115 & McDonald* (BRI, CANB, CNS, K, L); [3]Camerons Pocket, 12 km W of Calen [Mia Mia SF], Jan 2003, *Hambleton 4* (BRI); [3]23 km S of Eungella Dam Road on Cockies Creek Road, Crediton SF, Sep 2002, *Cumming 21133* (BRI). Port Curtis District: [4]Black Creek, SW base of Mt Sleipner, Mar 1989, *Forster PIF4999 & Hoy* (BRI, CANB, CNS, K, L, MEL, MO, NSW, US); [5]TR115 [now Castle Tower NP], Mt Coulston, 9 km NNW of Bororen, Sep 1989, *Gibson TOI828* (BRI); [5]Bindaree, NE of Miriam Vale & just S of Arthurs Seat, Jun 1995, *Melzer RM911* (BRI); [5]TR122, Wietalaba [now Wietalaba NP], 32 km S of Calliope, Oct 1989, *Gibson TOI740* (BRI, CANB); [5]TR202 [now Bulburin NP], Feb 1995, *Forster PIF16176* (BRI, CNS, MEL); [5]2.5 km N of Glassford Vale, TR353 [now Dawes NP], Sep 1989, *Forster PIF5674 & Bean* (BRI, CANB); [5]Bulburin NP, Pine Creek headwaters, Jan 2009, *Forster PIF34931 & Brushe* (BRI, MEL); [5]Bulburin NP, Cassilus Creek, Jan 2009, *Forster PIF34944 et al.* (BRI, CNS). Burnett District: [5]SF 695 Kalpowar, Mt Fort William, Mar 2000, *Forster PIF25439 & Booth* (BRI, CNS). Wide Bay District: [6]SF50 Glenbar, 1 km WSW of Mt Urah summit [now Glenbar NP], Feb 1993, *Forster PIF13130 & Machin* (BRI); [6]Glenbar NP, Cold Creek catchment, 8 km NW of Miva, Dec 2008, *Forster PIF34782 et al.* (BRI). *superscript number refers to the metapopulation in **Map 1**.

***Distribution and habitat*:** *Bosistoa pentacocca* subsp. *connaricarpa* occurs in eastern Queensland in five metapopulations from Mt Dryander to northeast of Gympie (**Map 1**). It invariably occurs in rainforest (microphyll to notophyll vineforest, often with *Araucaria cunninghamii* Aiton ex A.Cunn.) on diverse substrates (andesites, basalts, granites, granodiorites), often on alluvium or colluvium along ephemeral watercourses.

The type of *B. pentacocca* subsp. *connaricarpa* is from 'Rockhampton'; and the subspecies has only been recollected from the Mt Sleipner locality in this general area, thus this proposed metapopulation (4 on **Map 1**) consists of a single population. By contrast the other metapopulations are more diverse (2 has at least seven populations, 3 has at least

four populations, 5 has at least 13 populations and 6 has at least two populations).

***Typification*:** Domin (1913) cited a single collection in the protologue for *Bosistoa connaricarpa*, *viz.* "Queensland: Rockhampton, leg. Dallachy". Earlier he had stated "I give descriptions of new forms according to specimens preserved in the herbarium of the Royal Botanic Gardens at Kew" when basing names on collections other than his own from Australia (Domin 1911). It can be concluded from this that a holotype for this name should be at Kew.

Hartley (2013) gives the type of this taxon as "Rockhampton, Qld, 5 Feb. 1863, *J.Dallachy*; iso: MEL". Earlier he stated "TYPE: *Dallachy*, February 5, 1863, Queensland, Rockhampton" with an isotype at MEL (Hartley 1977). There are two sheets at MEL (67497 & 67503) of this collection, both labelled as an isotype by Hartley in January 1977. Both of these sheets have original collection labels from Dallachy with his collection number #297 and the locality of "Devils Creek", but no mention of Rockhampton.

There exists at K a sheet with a 'Phytologic Museum of Melbourne' label stating "Bosistoa sapindiformis F.M. Rockhampton" (although the specimen can now be clearly identified as *Bosistoa pentacocca* subsp. *connaricarpa*). The handwriting on this label is Mueller's. Whilst there is no mention of a collector or specific date on this label, further evidence can be found in a field label attached to the bottom left corner of the sheet. This field label is written in Dallachy's hand using blue crayon and amongst various points on plant habit, states "12 Dec". Dallachy is known to have made collections in the Rockhampton area "at least from the 5th [of] January 1863" to "at least April 16th" (Blake 1954) and this field label indicates that he was active there three weeks earlier. Prior to the Rockhampton area, Dallachy collected about Brisbane (Blake 1954).

It is unlikely that Domin saw any of the MEL sheets discussed and although labelled as isotypes by Hartley they are not duplicates of the K material as they were collected on a different date. Mueller distributed material sent to him by collectors to many herbaria, often with inadequate or different labels to that of those that were retained in MEL. Collectors such as Dallachy also often recollected material and it can be difficult to ascertain the specific collections subsequently cited by Mueller and others as they were generally unmounted in the 1800s and often with multiple sheets.

Precisely where Dallachy made his "Rockhampton" collection can probably never be resolved; however, it is likely that he returned to the same vicinity on subsequent occasions and so the collections by him of this plant in K and MEL may be from the same spot. His locality "Devils Creek" is possibly equivalent to Frenchmans Creek in a modern context for the Rockhampton area as this ephemeral watercourse flows into the Fitzroy River at Devils Elbow. The known locality for *Bosistoa pentacocca* at the southwestern base of Mt Sleipner is on the eastern side of Black Creek that is east of Mt Berserker and only about 3 km in a direct line from where Dallachy may have collected his specimens. Suitable habitat still exists in the upper reaches of Frenchmans Creek and should be explored to determine if *B. pentacocca* populations persist.

***Notes*:** Several populations of this subspecies occasionally exhibit characteristics of *B. pentacocca* subsp. *pentacocca*. These are at Kalpowar, Bulburin and Mt Urah (all at the southern end of the northern subspecies range) where the leaves can occasionally have three leaflet pairs; however, these are mixed in with leaves predominantly of 1 or 2 leaflet pairs.

Acknowledgements

I am very grateful to David Goyder (Royal Botanic Gardens Kew) for locating the Dallachy material in the general herbarium and Lucia Lopez Poveda for photographing material. Elucidation of Dallachy's handwriting (scrawl) was assisted by Peter Bostock, Gordon Guymer and Will Smith (BRI). The population of *Bosistoa pentacocca* at Black Creek was located with

the assistance of Dianne & Neil Hoy in 1989. Useful discussions of possible localities for Dallachy's 'Devils Creek' were held with Neil Hoy and Susan Cunningham. **Map 1** was prepared by Will Smith.

References

Auzi, A.A., Forster, P.I., Gray, A.I., Hartley, T.G., Waigh, R.D. & Waterman, P.G. (1997). Phloroglucinol derivatives from leaves of *Bosistoa pentacocca*. *Phytochemistry* 45: 1673–1678.

Blake, S.T. (1954). Some pioneers in plant exploration and classification. *Proceedings of the Royal Society of Queensland*. 66: 1–19.

Brophy, J.J., Goldsack, R.J. & Forster, P.I. (2007). Essential oils from the leaves of *Bosistoa* F.Muell. ex Benth. (Rutaceae). *Journal of Essential Oil Research* 19: 249–254.

Domin, K. (1911). First contribution to the Flora of Australia. *Feddes Repertorium Specierum Novarum Regni Vegetabilis* 9: 550–553.

—— (1913). Eighth contribution to the Flora of Australia. *Feddes Repertorium Specierum Novarum Regni Vegetabilis* 12: 388–390.

Duretto, M.F. & Forster, P.I. (2007). A taxonomic revision of the genus *Zieria* Sm. (Rutaceae) in Queensland. *Austrobaileya* 7: 473–544.

Forster, P.I. (1997). Rutaceae. In R.J.F. Henderson (ed.), *Queensland Plants – Names and Distribution*, 184–188. State of Queensland, Department of Environment: Brisbane.

—— (2002). Rutaceae. In R.J.F. Henderson (ed.), *Names and Distribution of Queensland Plants, Algae and Lichens*, pp. 177–181. Queensland Government, Environmental Protection Agency: Brisbane.

—— (2005). New species of *Philotheca* Rudge (Rutaceae) from Queensland. *Austrobaileya* 7: 175–181.

—— (2007). Rutaceae. In P.D. Bostock & A.E. Holland (eds.), *Census of the Queensland Flora 2007*, pp. 180–183. Queensland Herbarium, Environmental Protection Agency: Brisbane.

—— (2010). Rutaceae. In P.D. Bostock & A.E. Holland (eds.), *Census of the Queensland Flora 2010*, pp. 174–178. Queensland Herbarium, Department of Environment and Resource Management: Brisbane.

Freckleton, R.P. & Watkinson, A.R. (2002). Large-scale spatial dynamics of plants: metapopulations, regional ensembles and patchy populations. *Journal of Ecology* 90: 419–434.

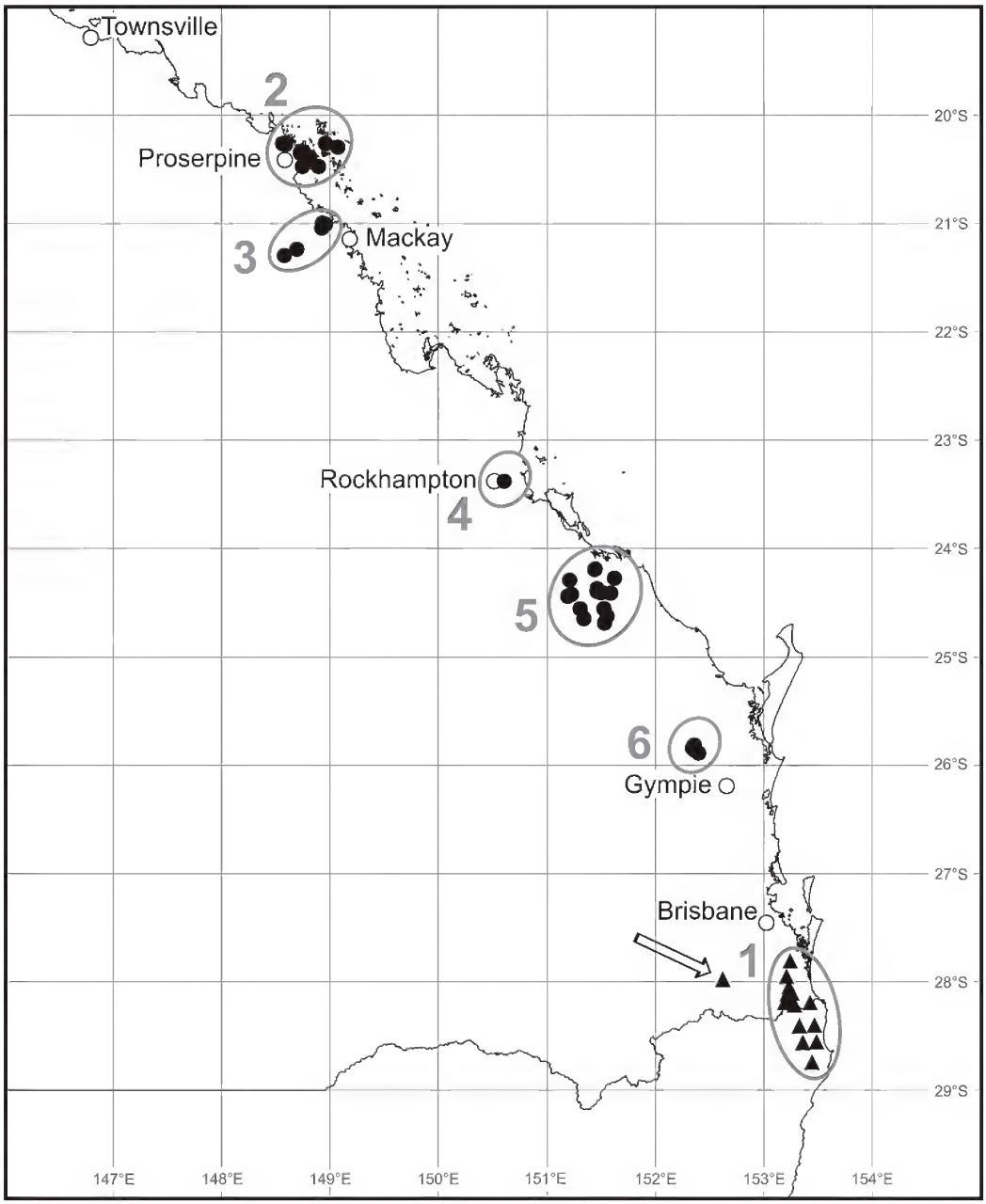
Hanski, I. & Gilpin, M. (1991). Metapopulation dynamics: brief history and conceptual domain. *Biological Journal of the Linnean Society* 42: 3–16.

Harden, G., McDonald, W.J.F. & Williams, J. (2006). *Rainforest Trees and Shrubs. A field guide to their identification*. Gwen Harden Publishing: Nambucca Heads.

Hartley, T.G. (1977). A revision of the genus *Bosistoa* (Rutaceae). *Journal of the Arnold Arboretum* 58: 416–436.

—— (2013). *Bosistoa*. In A.J.G. Wilson (ed.), *Flora of Australia* 26: 48–52. ABRS/CSIRO Publishing: Melbourne.

Stebbins, G.L. (1950). *Variation and Evolution in Plants*. Columbia University Press: New York.



Map 1. Distribution of *Bosistoa pentacocca* in eastern Australia. Numbered areas refer to proposed metapopulations (1–*B.pentacocca* subsp. *pentacocca* ▲, outlier population at Mt French arrowed; 2–6–*B. pentacocca* subsp. *connaricarpa* ●.

Three new species of *Pluchea* Cass. (Asteraceae: *Inuleae-Plucheinae*) from northern Australia

A.R. Bean

Summary

Bean, A.R. (2013). Three new species of *Pluchea* Cass. (Asteraceae: *Inuleae-Plucheinae*) from northern Australia. ***Austrobaileya* 9(1): 66–74**. Three new species of *Pluchea* Cass. are described; *P. longiseta* A.R.Bean from northern Western Australia, *P. mesotes* A.R.Bean from the Northern Territory, and *P. alata* A.R.Bean from central Queensland. All species are illustrated and distribution maps are provided. A revised key to the Australian of *Pluchea* species is provided.

Key Words: Asteraceae, *Pluchea*, *Pluchea alata*, *Pluchea longiseta*, *Pluchea mesotes*, Australia flora, taxonomy, identification key

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Introduction

Pluchea Cass. was revised for Australia by Hunger (1997), with seven species. Bean (2011) named two additional species of *Pluchea* from Queensland. Further investigations have revealed three additional species, which are named here: *P. alata* is endemic to the Aramac area of central Queensland, *P. longiseta* occurs in coastal and near-coastal parts of north-western Western Australia, and *P. mesotes* occurs in coastal parts of north-eastern Northern Territory.

Materials and methods

This study is based on herbarium specimens from BRI, DNA, MEL and PERTH, and (for *P. alata*) field investigations. Measurements of florets were made from material preserved in spirit or reconstituted in boiling water, while leaves, bracts and achenes were measured from dried specimens.

Common abbreviations in the text include NT (Northern Territory), Qld (Queensland), SA (South Australia), WA (Western Australia).

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Taxonomy

Pluchea alata A.R.Bean **sp. nov.** affinis *P. rubelliflorae* (F.Muell.) B.L.Rob. sed capitulo cylindrico sessili vel subsessili, flosculis marginalibus prope horum apices expansis, setis pappi in flosculis disci paucioribus et alis caulis usque ad 1.2 mm latis differens. **Typus:** Queensland. Mitchell District: First Spring, Edgbaston Reserve, NE of Aramac, 6 April 2012, *A.R. Bean 31641* (holo: BRI; iso: CANB, MEL).

Woody shrub to 70 cm high and 120 cm across. Stems erect to spreading, well-branched, glabrous throughout, conspicuously winged, wings 0.5–1.2 mm wide. Leaves sessile, elliptical, spreading, slightly fleshy, decurrent, 15–30 × 4.2–7 mm, 3.5–4.5 times longer than broad, eglandular, glabrous; margins denticulate; apex acute. Capitula cylindrical, 5–6.5 × 2.5–3 mm, in terminal clusters of 2–4; peduncles 0–1 mm long. Involucral bracts in several rows; outer bracts ovate, 1.2–2 × 0.4–0.6 mm, with apex acute, outer surface glabrous, margins entire, not ciliate and glabrous; median bracts lanceolate, 2–3.5 × 0.3–0.6 mm, apex acute, outer surface glabrous, margins glabrous; inner bracts linear, 3.7–4 × 0.8–0.9 mm, apex acute, outer surface glabrous, upper margins not ciliate, entire. Receptacle epaleate, verrucose, glabrous, flat, 1–1.2

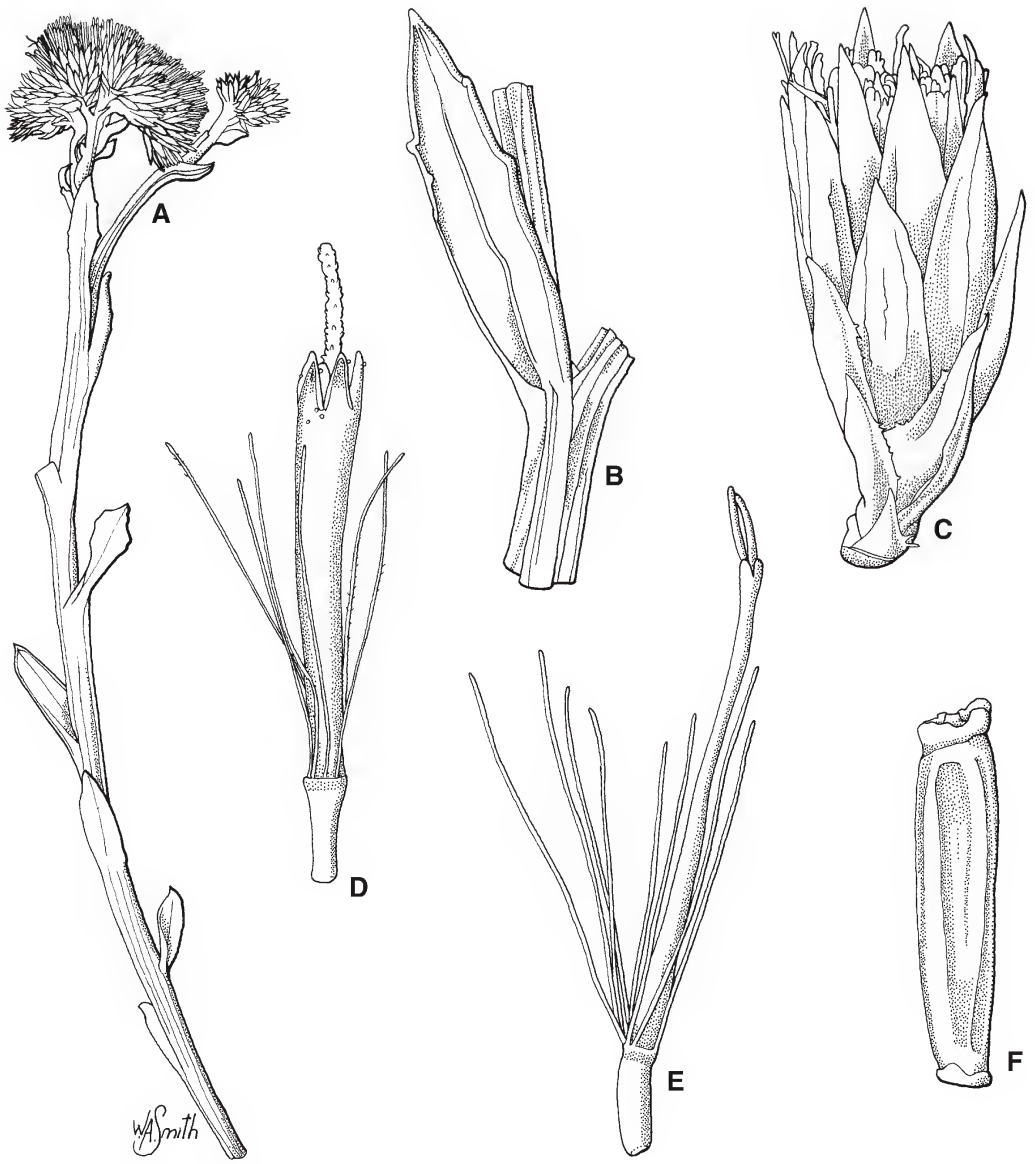

Fig. 1. ***Pluchea alata***. A. flowering branchlet ×1.5. B. leaf showing decurrent base and winged stem ×4. C. flowering capitulum ×12. D. disc floret ×16. E. outer floret ×24. F. achene ×48. A & B from *Bean 31648* (BRI); C–E from *Bean 31641* (BRI); F from *Fairfax s.n.* (BRI [AQ875934]).

mm diameter. Outer florets 55–75, female; corolla filiform, but expanded (0.2–0.25 mm wide) towards apex, 2.8–3.1 mm long, white; lobes 3 or 4, equal, triangular, 0.15–0.25 mm long, glabrous; style bifid, exserted, glabrous; pappus corona present, erect, cylindrical, *c.* 0.03 mm long; pappus bristles 4–12, 2.4–2.8 mm long, caducous, in a single whorl, not coherent at base, all of similar length, barbellate throughout;. Disc florets 5–13, ovary fully developed but infertile, pink; corolla cylindrical, 3–3.4 mm long, pink; lobes 5, triangular, 0.4–0.6 mm long, glabrous; anthers *c.* 1.5 mm long, including tail *c.* 0.15 mm long; style undivided, with obtuse sweeping hairs extending below the furcation;. Achenes developing only from outer florets; narrowly-ellipsoidal, 0.7–0.85 mm long, brown, glabrous; surface obscurely longitudinally striate; carpopodium prominent, white. **Fig. 1**.

***Additional specimens examined*: Queensland.** MITCHELL DISTRICT: Bowen Downs, in 1874, *Birch s.n.* (MEL); Big Spring, Edgbaston Station, N of Aramac, Apr 2005, *Fairfax s.n.* (BRI [AQ875934]); Edgbaston, NE of Aramac, Sep 2006, *Fensham 5549* (BRI); Edgbaston Station 33 km NNE of Aramac, Apr 2010, *Thompson MUT410 et al.* (BRI, PE); Measuring Spring, Edgbaston Reserve, NE of Aramac, Apr 2012, *Bean 31648* (BRI, NSW, US).

***Distribution and habitat*:** *Pluchea alata* is endemic to Queensland and is known from Edgbaston Reserve, NE of Aramac, and an old record from nearby Bowen Downs station (**Map 1**). It inhabits the margins of artesian springs, on saline soils.

***Phenology*:** Flowers and fruits have been recorded for April and September.

***Affinities*:** This species is allied to *Pluchea rubelliflora*, but differs by the woody stems, the relatively broader leaves (length 3.5–4.7 times width versus 4.5–12 times for *P. rubelliflora*), the more or less cylindrical capitula that are sessile or with peduncles up to 1 mm long (hemispherical capitula on peduncles (1–)2–10 mm long for *P. rubelliflora*); the outer florets expanded towards apex, with the lobes 0.15–0.25 mm long (florets not expanded and with lobes 0.08–0.12 mm long for *P. rubelliflora*); and the disc florets with 3–6 pappus bristles (6–18 bristles for *P. rubelliflora*). The stem wings are up to 1.2 mm wide, whereas for *P. rubelliflora* in the Aramac – Barcaldine area, the stem wings are 0.2–0.4 mm wide.

***Note*:** 'Bowen Downs' was a much larger station when this species was collected there in 1874. In view of the habitat occupied by this species, Birch's collecting locality was most likely in the Lake Huffer area (R. Fensham, *pers. comm.* Feb 2013).

***Conservation status*:** The species is known from fewer than 100 plants at the type locality. Applying the Red List criteria (IUCN 2012), a category of **Endangered** is recommended (Criterion D).

***Etymology*:** The epithet is from the Latin *alatus* meaning winged, in reference to the prominently winged stems of this species.

Pluchea longiseta A.R.Bean **sp. nov.** ab omnibus aliis speciebus *Plucheae* foliis carnosis, flosculis achenisque longioribus et pappi setis in verticillis duobus tribusve dispositis differens. **Typus:** Western Australia. North shore of Willie Creek inlet, Dampierland Peninsula, 6 September 1985, *K.F. Kenneally 9526A* (holo: BRI; iso: CANB, DNA, PERTH).

Pluchea sp. A; Wilson (1992: 950).

Pluchea sp. B; Wilson (1992: 950).

Pluchea sp. B Kimberley Flora (K.F. Kenneally 9526A); Western Australian Herbarium (1998–).

Woody shrub to 60 cm high and 80 cm across. Stems terete, erect to spreading, well-branched, glabrous or with very sparse multicellular eglandular hairs near growing point. Leaves sessile, narrowly-oblanceolate to linear, spreading, fleshy, not decurrent, 28–52 × 2–5.5 mm, 9–14 times longer than broad, eglandular, multicellular hairs sparse or absent; margins entire; apex acuminate or apiculate. Capitula in small terminal clusters, narrowly campanulate to cylindrical, 12–15 × 8–12 mm; peduncles 2–27 mm long, with 1–3 lanceolate bracts near the apex, each 2–4 mm long. Involucral bracts in several rows; outer bracts ovate, 2.5–5.5 × 1.5–3 mm, apex acuminate, outer surface glabrous, margins

entire and ciliate; median bracts lanceolate, 6.5–9.5 × 2.3–3 mm, apex acute to acuminate, outer surface glabrous, margins glabrous or with sparse eglandular hairs; inner bracts linear, 10.5–12 × 0.7–1.1 mm, apex laciniate, outer surface glabrous, upper margins glabrous, not ciliate. Receptacle epaleate, verrucose, glabrous, flat to concave, 1.7–2 mm diameter. Outer florets 100–200, female; corolla filiform, 8–9.5 mm long, pink; lobes 3, equal, triangular, 0.2–0.3 mm long, glabrous; style bifid, exserted, glabrous; pappus 8.2–9.2 mm long, pappus bristles 25–40, in 2 or 3 whorls, coherent at base, all of similar length. Disc florets 12–22, ovary fully developed but infertile, pale yellow; corolla cylindrical, 7.9–9.3 mm long, pink; lobes 4(–5), triangular, 0.5–0.6 mm long, glandular; anthers *c.* 3 mm long, including tail *c.* 0.2 mm long; style bifid, with obtuse sweeping hairs extending below the furcation. Achenes narrowly-ellipsoidal, 1.3–1.5 mm long, brown, with numerous appressed twin hairs; longitudinal ribs 4–6; carpopodium prominent, white. **Fig. 2**.

***Additional specimens examined*: Western Australia.** Montgomery Island, E of Koolan Island, May 1998, *Mitchell 5381* (DNA, PERTH); Cygnet Bay, Nov 1906, *Fitzgerald 1706* (PERTH); Buckley Plain, north of town boundary, Broome, Feb 2005, *Byrne 1374* (PERTH); Buckley Plain, 6 km NE of Broome, Nov 1987, *Foulkes 442* (DNA); *c.* 9 km NE of Mandora Homestead, between Broome and Port Hedland, Aug 1997, *Mitchell PRP1787* (PERTH); Loam 2 site, Mandora Marsh area, Oct 1999, *Duero WEL2-10 et al.* (DNA, PERTH); NW Island, Montebello Islands, Oct 2000, *Kenneally 11545* (PERTH); Hermite Island, Montebello Islands, Oct 2000, Kenneally 11573 (PERTH); below tip at side of DSI lease, Dampier Island, Sep 1987, *Glennon 397K* (PERTH); Boodie Island, S of Barrow and Middle Islands, Sep 2004, *Long VL360-3* (PERTH); Duffers Bore, 24 km N of Dampier Downs, Aug 1976, *Kenneally 5782* (DNA, PERTH); between T-bone Bay and hill towards lighthouse, Oct 1975, *Weber 4949* (PERTH); Willie Creek marsh, Jan 1985, *Foulkes 97* (PERTH); just N of Dragon Tree Soak, Great Sandy Desert, Aug 1977, *George 14747* (BRI, PERTH); 80 Mile Beach, N of Wooroo Creek, Jul 1941, *Burbidge 1300* (PERTH).

***Distribution and habitat*:** This species is endemic to Western Australia, mainly in coastal areas from the Montgomery Islands in the western Kimberley region, to the Cape Range, but also in a few scattered places away from the coast (**Map 1**). It inhabits samphire communities behind frontal dunes, saline marshy plains, and the margins of salty lagoons. Soils are usually pale and clayey but can have a sandy surface layer.

***Phenology*:** Flowers and fruits are recorded from May to February, with most collections made in September and October.

***Affinities*:** Because of the relatively large floral parts and the broad involucral bracts, this species resembles members of the genus *Streptoglossa* Steetz, and some specimens have previously been identified as such. But *Streptoglossa* species have ligulate outer florets and achenes with very dense twin hairs that conceal the surface. *Pluchea longiseta* has the tubular outer florets and almost glabrous achenes that are typical of this genus.

Pluchea longiseta does differ from the usual characteristics of *Pluchea* in that the pappus bristles are arranged in two or three whorls. *Pluchea* usually has pappus bristles in a single whorl. *P. longiseta* can be distinguished from other Australian species of *Pluchea* also by the fleshy leaves, and the longer achenes, pappus and florets.

***Conservation status*:** This species is relatively widespread, but no surveys have been carried out to determine population sizes. Its habitat is potentially under threat from port development and infrastructure in some areas. A category of **Data Deficient** is appropriate under the IUCN guidelines (IUCN 2012).

***Etymology*:** The epithet *longiseta* refers to the pappus bristles that are longer in this species than in any other Australian *Pluchea*.

***Note*:** According to Western Australian Herbarium (1998–), the taxon "Pluchea sp. A" listed in Wilson (1992) is synonymous with "Pluchea sp. B".

Fig. 2. ***Pluchea longiseta***. A. flowering branchlet ×1. B. flowering capitulum ×4. C. disc floret ×8. D. outer floret ×8. E. achene ×32. A from *Byrne 1374* (PERTH); B–D from *Kenneally 9526A* (PERTH); F from *Kenneally 11573* (PERTH).

Pluchea mesotes A.R.Bean **sp. nov.** affinis *P. indicae* (L.) Less. sed foliis angustioribus dentibus marginalibus paucis vel nullis, pedunculis capitulisque longioribus et pappi setis in quoque flosculo paucioribus differens. **Typus:** Northern Territory. Connexion Island, off Groote Eylandt, 29 September 1988, *P.K. Latz 10901* (holo: BRI; iso: DNA).

Multi-stemmed annual shrub to 100 cm high. Stems terete, erect to spreading, well-branched, with sparse to moderately dense multicellular eglandular hairs. Leaves sessile, narrowly-elliptical to spathulate, spreading, chartaceous, not resinous, glands absent or sparse, multicellular eglandular hairs sparse, bases not decurrent, 24–55 × 4–16 mm, 3.4–6.2 times longer than broad, margins entire or occasionally with 1–3 pairs of teeth, apex acute. Capitula in small terminal clusters, narrowly campanulate, 5.5–7 × 5–5.5 mm; peduncles 0–7 mm long, with 1–3 lanceolate bracts near the apex, each 1–2.5 mm long. Involucral bracts in several rows; outer bracts broadly ovate, 1.6–2.7 × 1–1.4 mm, with apex acute, outer surface glabrous, upper margins ciliate; median bracts lanceolate, 3.2–3.8 × 0.8–1 mm, apex acute, outer surface glabrous, upper margins ciliate; inner bracts linear, 4.8–5.2 × 0.2–0.3 mm, upper margins ciliate (cilia 0.05–0.1 mm long), outer surface glabrous. Receptacle epaleate, verrucose, densely hairy, flat, 1.4–1.7 mm diameter. Outer florets 60–120, female; corolla filiform, 4–4.5 mm long, colour unknown; lobes 3, equal, triangular, 0.1–0.15 mm long, glabrous; style bifid, exserted, glabrous; pappus 3.8–4.1 mm long, pappus bristles 12–15, in a single whorl, coherent at base, all of similar length; Disc florets 2–5, ovary fully developed but infertile; corolla cylindrical, 4–4.3 mm long, white to pale yellow; lobes 5, triangular, 0.4–0.7 mm long, glandular; anthers *c.* 1.9 mm long, including tail *c.* 0.3 mm long; style bifid, with obtuse sweeping hairs extending below the furcation. Achenes narrowly-ellipsoidal, 0.9–1 mm long, brown, with scattered appressed twin hairs; longitudinal ribs 2–5; carpopodium prominent, white. **Fig. 3**.

***Additional specimens examined*: Northern Territory.** Bennett Bay, Eastern Arnhem Land, Nov 1987, *Russell-Smith 4219 & Lucas* (BRI, DNA); Roper River, Sep 1867, *Gulliver s.n.* (MEL).

***Distribution and habitat*:** This species is apparently confined to the coastal parts of north-eastern Northern Territory (**Map 1**). It is recorded from "dune thicket", and from "coral-shell gravel above mangroves".

***Phenology*:** Flowers and fruits have been recorded for September and November.

***Affinities*:** *Pluchea mesotes* is related to *P. indica* but differs by the leaves 3.4–6.2 times longer than broad, that are without teeth or sometimes with a few small teeth (leaves 1.7–3.3 times longer than broad and with numerous prominent teeth for *P. indica*); the peduncles 0–7 mm long (versus 0–1 mm long for *P. indica*); the longer capitula 5.5–7 mm long (versus 4–5.5 mm for *P. indica*); the cilia on the upper margins of the inner involucral bracts 0.05–0.1 mm long (versus 0.2–0.3 mm long for *P. indica*); and the 12–15 pappus bristles (versus 17–25 for *P. indica*). *P. indica* occurs in the Darwin – Kakadu area, and on Cape York Peninsula, but apparently not in the region occupied by *P. mesotes*.

Conservation status: A category of **Data Deficient** is appropriate under the IUCN guidelines (IUCN 2012).

***Etymology*:** From the Greek *mesotes*, meaning 'in the middle position'. This is reference to the geographical position of this species in Australia compared with *P. indica*. The epithet is treated as a noun in apposition.

Acknowledgements

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Key to the *Pluchea* species in Australia

1 Leaves and stems glabrous (disregarding sessile glands) or with very few scattered hairs . **2**
1. Leaves and stems with frequent to abundant eglandular hairs or stalked glandular hairs . . **8**

2 Pappus bristles 8.2–9.2 mm long, in 2 or 3 whorls; leaves fleshy *WA* . . . . . **P. longiseta**
2. Pappus bristles 1.8–5 mm long, in a single whorl; leaves not fleshy **3**

3 Leaves narrow, 4.5–23 times longer than wide **4**
3. Leaves broad, 1.5–4.7 times longer than wide **6**

4 Leaves with dark punctate glands; stems not winged **5**
4. Leaves without punctate glands; stems narrowly winged *NT*, *Qld*, *SA*, *WA* . . **P. rubelliflora**

5 Capitula 6–7 mm long; disc florets 5–lobed; leaves 7–24 mm long; margins of involucral bracts fimbriate, eglandular *NSW*, *Qld* . . . . . **P. baccharoides**
5. Capitula 7–10 mm long; disc florets 4–lobed; leaves 18–54 mm long; margins of involucral bracts with stalked glands *Qld* . . . . . **P. punctata**

6 Stems winged; leaf glands absent *Qld* . . . . . **P. alata**
6. Stems not winged; leaf glands present **7**

7 Leaves not resinous; capitula 4–5.5 mm long, clustered into sessile groups of (1–)2–4 *NT*, *Qld* . . . . . **P. indica**
7. Leaves resinous; capitula 6–8.5 mm long, usually solitary; some peduncles on any given plant more than 3 mm long *WA*. . . . . **P. tetranthera**

8 Hairs on leaves extremely dense, obscuring leaf surfaces *NT*, *Qld*, *WA* . . . . . **P. ferdinandi-muelleri**
8. Leaf surfaces readily visible **9**

9 Hairs on leaves and stems predominantly gland tipped *NSW*, *NT*, *Qld*, *SA*, *WA* . . **P. dentex**
9. Hairs on leaves and stems all or mostly eglandular **10**

10 Leaves narrowly-elliptic or oblanceolate, 3.4–6.4 times longer than wide. **11**
10. Leaves obovate, 1.5–3.3 times longer than wide **12**

11 Leaf margins denticulate throughout; leaf surfaces with abundant, yellow glands; receptacle glabrous *Qld* . . . . . **P. xanthina**
11. Leaf margins entire or with 1 or 2 pairs of teeth; leaf surface glands absent or sparse, not yellow; receptacle hairy *NT* . . . . . **P. mesotes**

12 Capitula 5.5–7.5 mm long, not clustered, at least some peduncles more than 2 mm long; leaves often resinous *NSW*, *NT*, *Qld*, *SA* . . . . . **P. dunlopii**
12. Capitula 4–5.5 mm long, clustered into sessile groups of (1–)2–4; leaves not resinous *NT*, *Qld* . . . . . **P. indica**

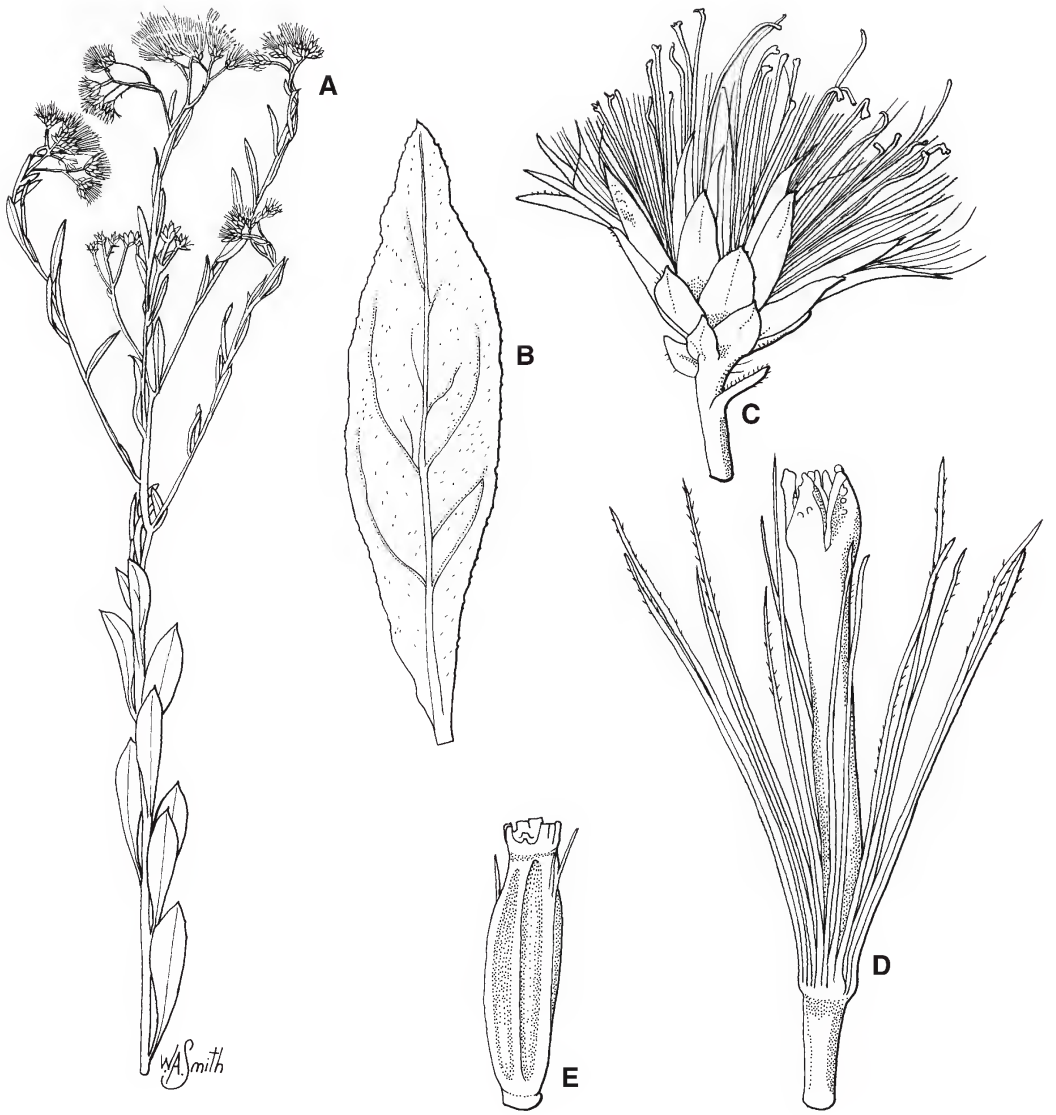


Fig. 3. ***Pluchea mesotes***. A. flowering branchlet ×0.5. B. leaf ×2. C. flowering capitulum ×6. D. disc floret ×16. E. achene ×32. A, C–E from *Latz 10901* (BRI); B from *Russell-Smith 4219 & Lucas* (DNA).

References

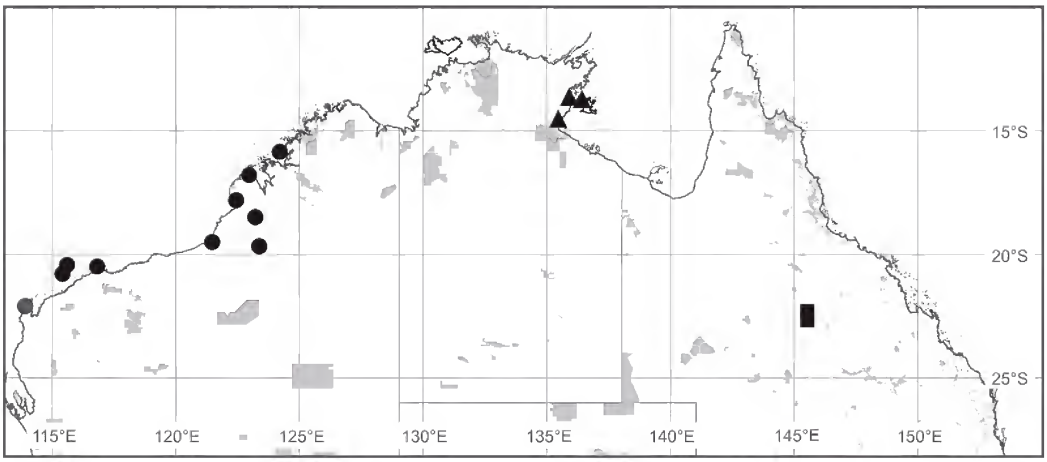
Bean, A.R. (2011). Two new species of *Pluchea* Cass. (Asteraceae: *Plucheinae*) from Queensland, Australia. *Austrobaileya* 8: 340–346.

Hunger, S. (1997). A survey of the genus *Pluchea* (Compositae, Plucheeae) in Australia. *Willdenowia* 27: 207–223.

Iucn (2012). *IUCN Red List Categories and Criteria*, Version 3.1, 2nd edn. IUCN – The World Conservation Union: Gland.

Western Australian Herbarium (1998–). *FloraBase—the Western Australian Flora*. Department of Environment and Conservation. http://florabase.dec.wa.gov.au/ Accessed 17 Feb 2013.

Wilson, A.J.G. (1992). *Pluchea*. In J.R. Wheeler (ed.), *Flora of the Kimberley Region*. Department of Conservation and Land Management: Como, Western Australia.



Map 1. Distribution of *Pluchea longiseta* ●, *P. mesotes* ▲ and *P. alata* ■.

Cryptocarya cercophylla W.E.Cooper (Lauraceae), a new species from Queensland's Wet Tropics

W.E. Cooper

Summary

Cooper, W.E. (2013). *Cryptocarya cercophylla* W.E.Cooper (Lauraceae), a new species from Queensland's Wet Tropics. ***Austrobaileya* 9(1): 75–79.** *Cryptocarya cercophylla* W.E.Cooper is described and illustrated. Notes on habitat, habit and distribution are provided. The new species is restricted to a small area near Boonjee in the Wet Tropics of north-eastern Queensland.

Key Words: Lauraceae, *Cryptocarya*, *Cryptocarya cercophylla*, rainforest, Australia flora, Queensland flora, Wet Tropics bioregion, new species

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Introduction

Cryptocarya R.Br. (Lauraceae) is a pantropical genus of 200–250 species of small to large trees, distributed from Africa, Asia, Malesia, Australia, the Pacific and South America (Le Cussan & Hyland 2007). In Australia, 48 species are now recorded, 39 or 40 are endemic and 36 of those occur in the rainforests of tropical Queensland.

Many *Cryptocarya* species are very restricted in distribution. Most species in Australia occur in various forms of rainforest, ranging from wet evergreen rainforest to gallery forest and other more seasonal rainforests, with a few also occurring in wet sclerophyll forest. They occur in a variety of substrates from sea level to 1600 m.

In February 1981, Laurence Jessup with J. Geoff Tracey and Tony Irvine collected the first specimens (*Jessup 319, Tracey & Irvine* and *Tracey 14993*) of the species described below as *Cryptocarya cercophylla* W.E. Cooper within the Boonjee Logging Area in the Russell River headwaters (now part of Wooroonooran National Park). The plant was originally thought to be a species of Icacinaceae. Flowering specimens were subsequently collected by Jessup, Gordon Guymer and Bill McDonald in October 1988, Bernie Hyland in July 1990, Bob Jago in August 1994 and Rigel Jensen in November 1994. By this time the plant was recognised as a species of *Cryptocarya*. Visiting Nigerian researcher, Olusegan Osunkoya with direction from Jensen, collected the first specimen with one fruit, in February 1994. Hyland *et al.* (2003) listed this entity under the phrase name *Cryptocarya* sp. (Boonjee BH 25794RFK), whereas the Queensland Herbarium listed it as *Cryptocarya* sp. (Boonjie L.W.Jessup+ 319) (Jessup 2007). However, it was not treated in either Hyland (1989) or the *Flora of Australia* (Le Cussan & Hyland 2007). With advice from Andrew Ford, a tree was located in January 2013 with enough fruiting material to enable a complete description of this species as *Cryptocarya cercophylla* W.E.Cooper.

Materials and methods

The study is based upon the examination of herbarium material from CNS together with relevant field observations. All specimens cited have been seen by the author.

Measurements of the floral parts and fruits are based on material preserved in 70% ethanol and fresh specimens in the field. Abbreviations in the specimen citations are: LA (Logging Area), NP (National Park), SFR (State Forest Reserve) and TR (Timber Reserve).

Accepted for publication 16 July 2013

Taxonomy

Cryptocarya cercophylla W.E.Cooper **sp. nov**. Similar to *Cryptocarya meissneriana* Frodin but differs in the leaf apex (distinctly caudate, with acumen 8–20 mm long and 1–2 mm wide, versus shortly acuminate or caudate with acumen up to 10 mm long and 2–4 mm wide), lateral veins (3–6 versus 7–10), tepals (erect and not opening widely versus opening widely at anthesis), and anther apex (acute versus truncate). **Typus:** Australia: Queensland. Cook District: Timber Reserve 1230, Bartle Frere, Boonjee Logging Area [east of Malanda], 17 November 1994, *R. Jensen 72* (holo: CNS [2 sheets + spirit], iso: BRI, CANB, MO *distribuendi*).

Cryptocarya sp. (Boonjee BH 25794RFK); Hyland *et al.* (2003).

Cryptocarya sp. (Boonjee); Cooper & Cooper (2004: 144).

Cryptocarya sp. (Boonjie L.W.Jessup+ 319); Jessup (2007: 92, 2010: 97).

Cryptocarya sp. Boonjee (B.Hyland 25794RFK); Hyland *et al.* (2010).

***Illustrations*:** Hyland *et al.* (2003), as *Cryptocarya* sp. (Boonjee BH 25794RFK); Cooper & Cooper (2004: 144) as *Cryptocarya* sp. (Boonjee). Hyland *et al.* (2010), as *Cryptocarya* sp. (Boonjee B.Hyland 25794RFK).

Small tree to 10 m, poorly formed and often with coppice shoots, stems to 12 cm diameter at breast height, not buttressed. Bark pale with sparse vertical elongated lenticels and fine fissures; twigs terete, green. **Leaves** simple, alternate, petiolate, discolorous, glabrous; petioles 7–13 mm long, grooved and yellowish; lamina ovate or elliptical, 53–100 mm long, 22–45 mm wide, thinly leathery, upper side glossy dark green, lower side shiny (less so than the upper surface), paler green, base attenuate or cuneate, apex caudate, acumen 8–20 mm long, 1.3–2 mm wide; margins entire and slightly recurved, mostly sinuous; venation brochidodromous, midrib depressed on upper side; secondary lateral veins indistinct, 3–6 pairs at 45–90° to the primary midrib, oil dots numerous (visible with a lens). **Inflorescences** axillary or rarely terminal, racemose or rarely paniculate, 4–7-flowered, 10–28 mm long, not exceeding leaves, rachis ± glabrous with occasional minute simple hairs; bracts triangular, *c.* 0.5 mm long and 0.2 mm wide, sparsely and minutely hairy, caducous. **Flowers** bisexual, actinomorphic, not fragrant, 3-merous, *c.* 2.5 mm long and 1.75 mm diameter; pedicels 0.6–2 mm long, sparsely and minutely hairy; perianth tube 2.5–2.8 mm long, *c.* 1.5 mm wide at apex, inner surface hairy, outer surface glabrous; tepals 6, in 2 whorls of 3, glabrous outside, sparsely hairy inside, creamy-green or cream, erect at anthesis; outer tepals 1.2–1.7 mm long, 1.2–1.5 mm wide; inner tepals *c.* 1.7 mm long and 1.6 mm wide; stamens with filaments sparsely hairy, *c.* 5 mm long; gland heads conical, glabrous, *c.* 1 mm long and 0.4 mm wide, stalks sparsely hairy or glabrous *c.* 0.2 mm long; anthers 6 introrse and 3 extrorse, 2-locular, inner and outer anthers *c.* 0.5 mm long and 0.5 mm wide, glabrous; staminodes 3, head cordate, sessile, *c.* 0.7 mm long; ovary glabrous to sparsely hairy, 0.8–1 mm long, *c.* 0.5 mm wide; style glabrous, 1.2–1.6 mm long. **Fruit** a nut, appearing as an inferior drupe, elliptical, rarely ovoid or obovoid, mostly asymmetric at base with one side slightly lobed, 16.5–20 mm long, 10–14.5 mm wide, ribbed, glabrous, red to shiny black at maturity, epicarp 0.4–0.6 mm thick, mesocarp + epicarp *c.* 1.8 mm thick, mesocarp green, stigma persistent at apex with diameter *c.* 1.5 mm, pedicel 1–2.8 mm long; seed solitary, 16–19.5 mm long, 8–12.5 mm wide; endocarp beaked at base, cream, ribbed; cotyledons white, uniform in texture (not ruminate), radicle apical. **Figs. 1 & 2.**

***Additional selected specimens (from 25 examined)*: Queensland.** Cook District: Tolga, cultivated, Jan 1995, *Sankowsky 1437* (CNS); Atherton, cultivated, Jul 1990, *Gray 5210* (CNS); Butchers Creek, *c.* 20 km ESE of Yungaburra, Stockwellia site, Jan 1985, *Morawetz, Waha & Weber 114-30185* (CNS); TR 1230 Boonjie LA, Feb 1981, *Jessup 319, Tracey & Irvine* (BRI); Wooroonooran NP, Stockwellia site, July 2000, *Forster PIF25913, Booth & Jensen* (BRI); TR 1230, Bartle Frere, Boonjee LA, July 1990, *Hyland 14052* (CNS), *14053* (CNS), *25793RFK* (CNS), *25794RFK* (CNS), *25795RFK* (CNS); TR 1230, Boonjee LA, the headwaters of the Russell River, Feb 1981, *Tracey 14993* (CNS); Wooroonooran NP, Stockwellia area south of road to Mt Bartle Frere, Site 216, Dec 2009, *Ford 5636 & Cooper* (BRI, CNS);

Stockwellia site, Boonjee, Wooroonooran NP, Jul 2011, *Cooper 2136 & Ford* (CNS), Oct 2012, *Cooper 2165* (CNS); SFR 755, Bartle Frere, Gosschalk LA, Sep 1994, *Gray 5774* (CNS); TR 1230, Boonjee LA, Feb 1994, *Osunkoya 1* (CNS); Wooroonooran NP, along Russell River track between lookout and Chucklunga track, Sep 2012, *Ford 6082* (CNS); Wooroonooran NP, Donkey Track near Zig Zag, Mar 2003, *Forster PIF29259 & Cooper* (BRI); Wooroonooran NP, along Chucklunga track, Jan 2013, *Cooper 2210 & Ford* (CNS); Palmerston Ridge Track, Feb 1995, *Hunter 1154* (BRI).

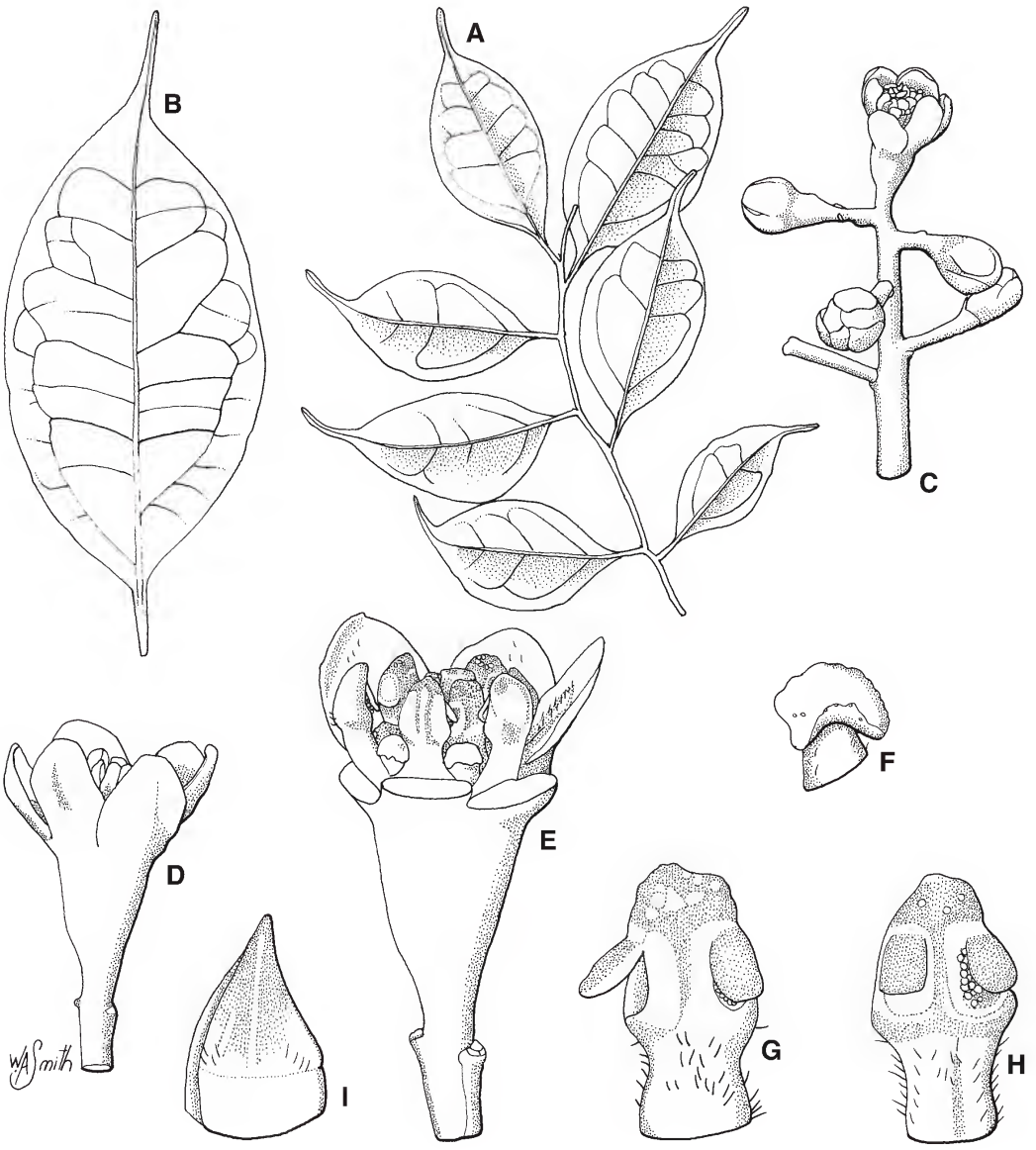


Fig. 1. ***Cryptocarya cercophylla.*** A. stem with leaves showing main lateral veins ×0.5. B. leaf showing primary, secondary and some tertiary venation ×1. C. inflorescence showing open flower, buds and bracts on pedicels ×4. D. flower (side view) ×8. E. flower (side view with 3 tepals removed) ×12. F. staminode ×32. G. anther (inner whorl) ×32. H. anther (outer whorl) ×32. I. gland showing head and stalk ×1. A & B from *Forster PIF29259 & Cooper* (BRI); C–I from *Jensen 72* (CNS). Del. W. Smith.

Fig. 2. ***Cryptocarya cercophylla*** fruiting stem (*Cooper 2210 & Ford* [CNS]). Photo: A. Ford.

***Distribution and habitat*:** *Cryptocarya cercophylla* is endemic to Wooroonooran National Park within the Wet Tropics bioregion of north-eastern Queensland, where it is known to occur in a small area between what is locally referred to as the Stockwellia site at Boonjie and the nearby Russell River, at altitudes 580–680 m. The species may well occur in a broader area of the western Russell River catchment (**Map 1**).

Cryptocarya cercophylla grows as an understory tree in a high rainfall area of notophyll rainforest on clay soils derived from metasediments. Tree species that it co-occurs with are *Stockwellia quadrifida* D.J.Carr, S.G.M.Carr & B.Hyland, *Beilschmiedia oligandra* L.S.Sm., *Ceratopetalum virchowii* F.Muell., *Elaeocarpus johnsonii* F.Muell, *Endiandra dichrophylla* F.Muell., *Flindersia bourjotiana* F.Muell., *Franciscodendron laurifolium* (F.Muell) B.Hyland & Steenis and *Peripentadenia mearsii* (C.T.White) L.S.Sm., *Bobea myrtoides* (F.Muell.) Valeton and *Aceratium doggrellii* C.T.White. It appears to favour areas disturbed by landslips.

***Phenology*:** Flowers have been recorded in July, October, November and December: fruits have been recorded in January and February.

***Notes*:** In cultivation, *Cryptocarya cercophylla* has flowered as a shrub at 1.5 m tall; however, flowering collections in the wild are only known from trees 6 m and above.

Fallen stems produce adventitious roots, which appear to eventually grow into individual trees following decomposition of the fallen stem. Evidence of such a phenomenon can be seen as a number of 'individuals' occurring close together (3–5 m) and in a straight line.

***Affinities*:** *Cryptocarya cercophylla* appears to be most similar to *C. meissneriana* from southeast Queensland and northeast New South Wales but differs from this species in the leaf apex (distinctly caudate, with acumen 8–20 mm long and 1–2 mm wide, versus shortly acuminate or caudate with acumen up to 10 mm long and 2–4 mm wide), leaf venation (3–6 secondary lateral veins versus

7–10 secondary lateral) and the tepals erect and not opening widely at anthesis (versus tepals opening widely at anthesis).

***Conservation status*:** *Cryptocarya cercophylla* is a geographically restricted species and can be classified as **Vulnerable** (Criterion D2) using the criteria of the IUCN (2001).

***Etymology*:** The specific epithet is derived from the Greek, *kerkos* (tail), and *phyllon* (leaf), in reference to the distinctive caudate or tail-like leaf apices.

Acknowledgements

Frank Zich and Darren Crayn are thanked for support and access to CNS herbarium, Andrew Ford and Cath Moran for assistance and good company in the field and especially Andrew for finding the elusive fruiting tree, Peter Bostock and Will Smith for the map and illustrations. Laurie Jessup enlightened me regarding the discovery of the plant. Darren Crayn and Andrew Ford made worthwhile suggestions to an earlier manuscript. Permits to collect in National Parks and State Forests were issued by the Queensland Department of Environment and Resource Management.

References

Cooper, W. & Cooper, W.T. (2004). *Fruits of the Australian Tropical Rainforest.* Nokomis Editions: Melbourne.

Hyland, B.P.M. (1989). A revision of *Lauraceae* in Australia (excluding *Cassytha*). *Australian Systematic Botany* 2: 135–367.

Hyland, B.P.M., Whiffin, T., Christophel, D.C., Gray, B. & Elick, R.W. (2003). *Australian Tropical Rain Forest Plants. Trees, Shrubs and Vines.* CD–ROM. CSIRO Publishing: Melbourne.

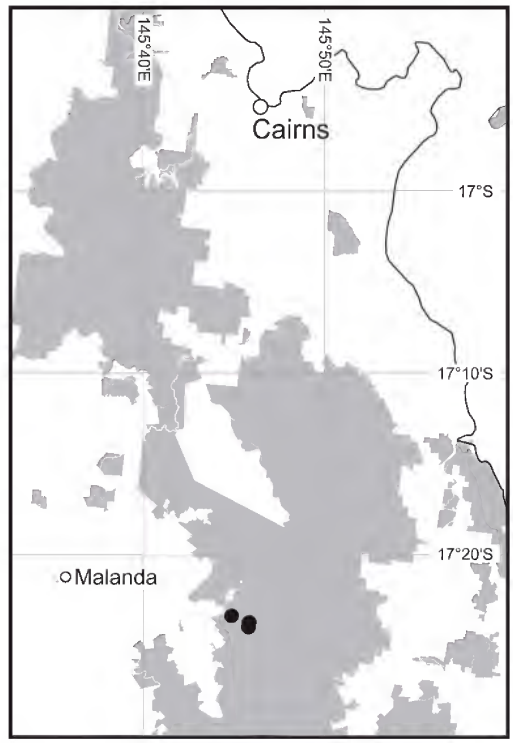
Hyland, B.P.M., Whiffin, T. & Zich, F. (2010). *Australian Tropical Rain Forest Plants Edition 6 (online version). CSIRO. http://www.anbg.gov.au/cpbr/cd-keys/rfk/index.html Accessed October 2011.*

Iucn (2001). *IUCN Red List of Categories and Criteria: Version 3.1.* IUCN Species Survival Commission: Gland (Switzerland)/Cambridge (United Kingdom).

Jessup, L.W. (2007). Lauraceae. In P.D. Bostock & A.E. Holland (eds.), *Census of the Queensland Flora 2007,* p. 54. Environmental Protection Agency, Brisbane.

—— (2010). Lauraceae. In P.D. Bostock & A.E. Holland (eds.), *Census of the Queensland Flora 2010,* p. 92. Environmental Protection Agency, Brisbane. http://www.derm.qld.gov.au/wildlife-ecosystems/plants/pdf/qld-flora-census.pdf Accessed October 2011.

Le Cussan, J. & Hyland, B.P.M. (2007). *Lauraceae.* In A.S. George (ed.), *Flora of Australia.* 2: 106–223. Australian Biological Resources Study: Canberra.



Map 1. Distribution of *Cryptocarya cercophylla* in north-east Queensland. Shaded area on map indicates Wooroonooran National Park.

Viola perreniformis (L.G.Adams) R.J.Little & G.Leiper, *stat. nov.*, with notes on Australian species in *Viola* section *Erpetion* (Violaceae)

R. John Little[1] & Glenn Leiper[2]

Summary

Little, J. & Leiper, G. (2013). *Viola perreniformis* (L.G.Adams) R.J.Little & G.Leiper, *stat. nov.*, with notes on Australian species in *Viola* section *Erpetion* (Violaceae). ***Austrobaileya* 9(1): 80–101.** *Viola perreniformis* (L.G.Adams) R.J.Little & G.Leiper is recognized as a distinct species in section *Erpetion* in Australia. A description of the species is presented. Leaf and floral characters of four closely related species in section *Erpetion*, *V. banksii* Thiele & Prober, *V. hederacea* Labill. subsp. *hederacea*, *V. perreniformis stat. nov.*, and *V. silicestris* Thiele & Prober, are compared and discussed. Various aspects of the biology of these species are discussed and provisional keys are presented based on floral and leaf characters. Comments are also provided for four other species in section *Erpetion*: *V. cleistogamoides* (L.G.Adams) Seppelt, *V. eminens* Thiele & Prober, *V. fuscoviolacea* (L.G.Adams) T.A.James, and *V. sieberiana* Sprengel, and a putative hybrid, *V.* × *zophodes* Thiele & Prober.

Key Words: Violaceae, *Viola*, *Viola* section *Erpetion*, *Viola banksii*, *Viola betonicifolia*, *Viola caleyana*, *Viola cleistogamoides*, *Viola eminens*, *Viola fuscoviolacea*, *Viola hederacea* subsp. *hederacea*, *Viola perreniformis*, *Viola sieberiana*, *Viola silicestris*, *Viola* × *zophodes*, anther gland, cleistogamy, nectary

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Introduction

Viola hederacea Labill. subsp. *perreniformis* L.G.Adams was one of eight subspecies recognized by Adams in the *V. hederacea* complex in Australia (Adams 1982a,b). This was the first attempt to classify the diversity of forms that had been assigned to *V. hederacea sensu lato* in section *Erpetion* (Sweet) Benth. & Hook.f. Later, James (1990) recognized seven forms (A through G) of *V. hederacea* in New South Wales based on leaf shape and pubescence, and in addition, elevated three of Adams' subspecies to species rank. Thiele & Prober (2003) summarized the taxonomic status of each subspecies of *V. hederacea* described by Adams with all subspecies except subsp. *perreniformis* and subsp. *curtisae* L.G.Adams having been elevated to species rank.

In the original description, *Viola hederacea* subsp. *perreniformis* was distinguished from *V. hederacea* subsp. *hederacea* by the erect, soft, short pubescence, by the corolla being more or less concolorous, pale (lazuline) blue-violet, with the anterior petal white at the base with violet-coloured veins, and distinguished from other *V. hederacea* subspecies by suborbicular leaves with a deeply cordate base (Adams 1982a). The epithet 'perreniformis' means 'very reniform.' Interestingly, the adjective 'reniform' with respect to leaves of subsp. *perreniformis* was not mentioned in the Latin diagnosis and appears only in the description of subspecies (Adams 1982b). The leaves of subsp. *hederacea* were stated by Adams (1982b) to be variable *but never suborbicular* (authors' emphasis). Adams reported that subsp. *perreniformis* occurred in coastal regions between Cairns, Queensland (Qld) and Sydney, New South Wales (NSW).

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Some Australian botanists have considered *Viola hederacea* subsp. *perreniformis* as warranting specific status (e.g. Thiele & Prober 2003), but the nomenclatural change has not been made. Based on a study of the holotype and isotype as well as other collections of the *V. hederacea* complex at BRI, CANB, and NSW, and recent field observations by the authors, we believe subsp. *perreniformis* differs sufficiently from subsp. *hederacea* to warrant recognition at species rank, as *V. perreniformis*. The close relationship among the four taxa, *V. banksii*, *V. hederacea* subsp. *hederacea*, *V. perreniformis* and *V. silicestris*, can be seen in the morphology of their leaves and flowers.

Long regarded as a difficult taxon because of its many leaf forms, recent studies of the *Viola hederacea* complex in Australia in section *Erpetion* have begun to clarify relationships among taxa in this group. In 2003, Thiele & Prober presented the most comprehensive study and summary to date of species in section *Erpetion* (Thiele & Prober 2003), which included a circumscription of species in the *V. hederacea* complex, descriptions of several new species including *V. banksii*, and a key to most members of the complex. Their circumscription of *V. hederacea* did not include *V. hederacea* subsp. *perreniformis*, which they believed to be a taxon distinct from *V. hederacea*. Thiele & Prober (2006) described *V. silicestris* as a new species and discussed similarities and differences of it compared to four other species in section *Erpetion*: *V. cleistogamoides* (L.G.Adams) Seppelt, *V. fuscoviolacea* (L.G.Adams) T.A.James, *V. hederacea* and *V. sieberiana* Sprengel.

During our study of *Viola perreniformis*, we found that *V. banksii*, *V. hederacea* subsp. *hederacea*, and *V. silicestris* were the taxa most often confused with *V. perreniformis stat. nov.* In this paper we examine and compare these four species (collectively referred to herein as the "four taxa") with new and existing data, document previously unreported observations of various morphological features, and suggest topics for future study. The taxonomy of section *Erpetion* is challenging and far from complete. The four taxa and other species in the section appear to have many unique features not known to occur in other *Viola* species.

Materials and methods

In November and December 2011 and January 2012, the first author examined herbarium specimens in the *Viola hederacea* complex at the herbaria BRI and NSW, including specimens identified as subsp. *perreniformis*. Both authors conducted numerous field studies in Qld and NSW during this timeframe. In 2013, the first author continued study of species in the *V. hederacea* complex at the herbaria CANB and NSW, and both authors examined specimens at BRI identified as subsp. *perreniformis* and subsp. *hederacea*. Scanned images were examined of slides of the type of *V. hederacea* at CANB.

At BRI, all specimens previously determined as subsp. *perreniformis* were compared with the isotype housed at BRI and an image of the holotype housed at CANB. Specimens were then sorted into three groups: 1) specimens that matched or closely resembled the holotype and isotype (these specimens are listed below under *Additional specimens examined*); 2) specimens generally similar to the holotype and isotype, but with leaves too immature or in too poor a condition to make a definitive determination; and 3) specimens which, in the authors' opinion, did not fit the concept of the *perreniformis* taxon, most of which are referable to subsp. *hederacea*. Over 1000 high-resolution, digital photographs were taken of herbarium specimens to facilitate further study.

Field observations of *Viola perreniformis* were made by both authors in February 2013 at Nightcap National Park (NP) in NSW. The second author made additional observations and collections of this taxon in March, April, and May 2013 at Crows Nest NP and in March 2013 at Moogerah Peaks NP, both in Qld. In June 2013, the second author collected fresh flowers of *V. banksii* from Springbrook NP (possibly a horticultural escape) and Venman Bushland NP and *V. hederacea* from Springbrook NP, all sites in Qld; the anther

glands on these flowers were then observed with a stereozoom microscope. Using a stereozoom microscope with a camera attachment, the first author obtained micro-photographs of flowers and anther glands of *V. banksii* and seeds of *V. perreniformis* and *V. betonicifolia*.

The species description is based on a composite of observations and measurements of leaves, petioles, peduncles, and flowers from a) the holotype and isotype; b) from herbarium specimens at BRI, and c) from plants collected by the authors in 2012 and 2013 and photographs taken of fresh material. The number of 'crenations' (rounded lobes) on leaf margins were recorded only from one side of a leaf because on herbarium specimens, overlapping leaves often prevented observation of the entire margin.

As used herein in reference to pubescence, the term pilose means soft, thin, straight, and clearly separated hairs; the type of hairs on leaf surfaces of *Viola perreniformis*. Villous means ± densely covered with soft, thin, long, straight or sometimes shaggy hairs, not clearly separated; the type of hairs often found on petioles and peduncles of *V. perreniformis*.

Common abbreviations used in specimen citation include CP (Conservation Park), NP (National Park) and SF (State Forest).

Taxonomy

Viola perreniformis (L.G.Adams) R.J.Little & G.Leiper, **stat. nov.**; *Viola hederacea* Labill. subsp. *perreniformis* L.G.Adams, *Fl. Aust.* 8: 386 (1982). **Type:** Queensland. Port Curtis District: *c.* 40 km WSW of Gladstone, Many Peaks Range, 2 June 1977, *M.D. Crisp 2751 & R.K. Ellyard* (holo: CANB, image!; iso: BRI).

Plants perennial, often appearing acaulescent, 3–6.5 cm high, stoloniferous, rooted sections of the stolon forming rosettes of leaves on short, fleshy rhizomes. **Stems** sometimes present, 1–8 cm long. **Leaves:** stipules narrow-ovate or lanceolate, margin irregularly fimbriate, apex acute, long-aristate; petiole 9–23 cm long, sparsely or densely pilose or villous, occasionally glabrous; blade reniform, sub-reniform, or ovate (outline ovate, orbicular, suborbicular, or semicircular), 5.5–23 mm long, 7–27 mm wide, base cordate or deeply cordate, occasionally subtruncate or truncate, often with distinct sinus between lobes; margins ciliate or eciliate, uniformly or irregularly crenate from basal lobes to apex, 4–9(–10) lobes per side, sometimes poorly defined, occasionally some lobes ± serrate, apex acute, obtuse, or rounded, occasionally ± truncate, the midvein terminating in a blunt mucro; abaxial surfaces of mature and immature leaves sparsely or densely pilose, with hairs scattered on 1° and 2° veins or over entire surface, occasionally glabrous, small or immature leaves sometimes tomentose; adaxial surfaces of mature and immature leaves sparsely or densely pilose, with hairs scattered over entire surface, occasionally glabrous; blades bi-colored, darker green adaxially, lighter abaxially. **Flowers** solitary, peduncles arising from a fleshy, usually vertical rhizome, extending above the leaves, 25–77 mm long, sparsely or densely pilose or villous, occasionally glabrous; bracteoles narrowly linear or aciculate, 2.5–5 mm long, opposite or alternate, often above the middle during capsule development; sepals lanceolate, margin entire, scarious, eciliate, apex acute, usually gland-tipped, auricles not prominent, *c.* 0.5 mm long; upper petals erect in young and reflexed in mature flowers, pale blue-violet on both surfaces, white basally, occasionally with a faint or prominent violet-coloured blotch distal to the proximal white area; lateral petals spreading in new and twisted in mature flowers, pale blue-violet on both surfaces, occasionally appearing white distally, white basally with a green and white, ± 1–2 mm long, ± 1–2 mm wide indurate area at the base, often with a faint or prominent violet-coloured blotch distal to the proximal white area, with faint or prominent violet-coloured veins, usually with a dense patch of white clavate and cylindrical beards on proximal third of petal, often with some tips violet-coloured, distal beards sometimes entirely violet-coloured; lowest petal obovate to oblong, usually white on proximal half with a prominent green and white, 1–2 mm long, 1–2 mm wide indurate area at the base,

the distal half of petal pale blue-violet, the veins violet-coloured, prominent on adaxial surface, faint or prominent on abaxial surface, usually not extending to distal margin of petal, the midvein and the two adjacent veins distinct, prominent, parallel, ± same length, scarcely or not anastomosing (without evident, interconnecting 2° veins), 5–9 mm long, apex retuse, truncate, rounded, occasionally with a short, sharp or rounded point between two lobes, spur not present; style geniculate near attachment to ovary, ± terete, style head glabrous, not differentiated from style shaft; anthers cream-coloured, anther glands pale green, smooth, *c.* ½–2/3 as long as anther, prominent, margins of terminal anther appendages not hairy; pollen cream-coloured. **Capsules** 5–6 mm long, 3-valved, often purple-spotted, glabrous. **Seeds** ovoid, surface uneven to irregularly rugose, 1–1.2 mm long, shiny or dull dark brown mottled with patches of light brown or tan, elaiosome not present.

***Additional selected specimens examined*: Queensland.** Cook District: Intersection of road to radio tower and Longlands Gap Road, Longlands Gap SF, Aug 2007, *Zich 617 & Quinn* (BRI, CANB). North Kennedy District: Mt Fox, Dec 1949, *Clemens s.n.* (BRI [AQ115414]). South Kennedy District: Dalrymple Heights & vicinity, Jul 1947, *Clemens s.n.* (BRI [AQ115415]). Leichhardt District: Carnarvon Creek Gorge, 70 miles [112 km] NW of Injune, May 1962, *Johnson 2411* (BRI); Blackdown Tableland, *c.* 1 km E of main N–S road crossing, Jan 1973, *Henderson H1392 & Sharpe* (BRI). Port Curtis District: *c.* 60 km SW of Gladstone, 8 km SE of Amys Peak, Jun 1977, *Crisp 2793* (BRI); Kroombit SF 316, Aug 1984, *Gibson 634* (BRI); Castletower Mt, Oct 1988, *Randall 591* (BRI); Portion 10 V, Oaky Creek, Castletower, Apr 1989, *Gibson TOI482* (BRI). Wide Bay District: Mt Woowonga, Woowonga Range SF, Jan 1982, *Forster PIF1153* (BRI); Tinana Creek at Missings Crossing, May 2001, *Stephens 138903A(11)* (BRI); Mt Boulder, SE of Gympie, Oct 1993, *Bean 6831* (BRI); Mapleton Logging Area, Mapleton SF, W of Mapleton, Mar 1998, *Bean 13121* (BRI, CANB, HO, MEL, NSW). Moreton District: Mt Mee SF 893, 2 km SE of Forestry office, Sep 1997, *Halford Q3357 & Boyle* (BRI); Alice Creek, 7.5 km ESE of Murphys Creek Rail Siding, Aug 1990, *Forster PIF7100 & Bird* (BRI); Mt Edwards NP, 14 km W of Boonah, Sep 1992, *Forster PIF11483 & Reilly* (BRI); Mt Edwards, Moogerah Peaks NP, *c.* 14 km W of Boonah, Feb 2010, *Halford Q9754* (BRI); Mt May, Sep 1992, *Forster PIF11794 et al.* (BRI); Southern slopes of Mt Greville, SW of Lake Moogerah, Jan 2007, *Phillips 1679 & Phillips* (BRI); Between N and S peaks of Mt Maroon, W of Rathdowney, Apr 2009, *Phillips 2006 & Phillips* (BRI); Cronins Creek between Mt Barney & Mt Ernest, Dec 1932, *White 8757* (BRI); Near summit of Mt. Lindsay [Lindesay], Sep 1973, *Dowling 109* (BRI). **New South Wales.** Terania Creek, 10 km NNE of The Shannon [Channon], Feb 1980, *Coveny 10628* (BRI); Summit of Mt Carnham, W of Grafton, in the Baryugil area, Jun 1993, *Bryant s.n.* (BRI [AQ566756]); Summit of Munningyundo Mt, Nymboida NP, between Grafton and Glen Innes, Mar 2003, *Bean 20105* (BRI); North Rocks Road, Nightcap Range, *Little 13697 & Leiper* (BRI).

***Distribution and habitat*:** The species occurs in a series of disjunct localities from west of Cairns, north Qld, to Sydney in NSW. Recorded elevations of specimens examined in this study range from 75 m at Oaky Creek, Castletower to 1160 m at Mt Lindesay, both in Qld. Of the 14 specimens that provide elevation data nearly 60% were collected at 500 m or higher. Microhabitat situations reported by collectors include: moist situations in wet sclerophyll forests, in woodlands, in open eucalypt forests, on steep slopes, in crevices of rocky cliffs, cascading over rock faces with or without water flowing, on rhyolite or on rocky brown loam, granite, or sandstone; east, south, and west-facing slopes (**Fig. 1**).

***Phenology*:** Flowering and fruiting occurs throughout the year.

***Conservation status*:** *Viola perreniformis* is widespread, occurs in several National Parks, and is not known to be at risk.

Notes on *Viola* section *Erpetion*

Observations on aspects of morphological variation and reproductive biology focus primarily on the four taxa *Viola banksii, V. hederacea* subsp. *hederacea*, *V. perreniformis* and *V. silicestris*. Information is also presented for four other species in the section, *V. cleistogamoides, V. eminens* Thiele & Prober, *V. fuscoviolacea*, and *V. sieberiana* and a putative hybrid, *V.* × *zophodes* Thiele & Prober. Other taxa recognized in section *Erpetion* that are not discussed include *V. hederacea* subsp. *curtisiae* and *V. improcera* L.G.Adams.

Stolons and Rhizomes. All species in section *Erpetion* produce stolons and two small bracts are always present between stolon nodes. Thiele & Prober (2003) reported that

Fig. 1. ***V. perreniformis***. Habitat, Crows Nest NP, Qld, Mar 2013. Photo: G. Leiper.

rootstocks of *Viola banksii* and *V. hederacea* were sometimes somewhat swollen and bulbous at the stem bases, but they were not or scarcely swollen in *V. silicestris* (Thiele & Prober 2006). The authors made similar observations for these species.

Stolons in section *Erpetion* are initially produced on the surface. Over time depending on their location, they can become buried with eroded soil, leaf litter, etc. Numerous herbarium specimens and the author's recent collections show that buried, subterranean stolons can eventually become lignified in some species. This phenomenon is not known to have been previously reported for Australian species of *Viola* in the section. Although a buried stolon is technically a 'rhizome,' buried stolons of these species do not become thick and fleshy, but retain their narrow shape.

A stolon node situated in a suitable site has the capacity to produce a vertically oriented rhizome and a rosette of leaves. As a rhizome matures it elongates vertically, its diameter increases, and it becomes fleshy, similar to many other *Viola* species. New leaves are produced distally as older leaves die. Leaf abscission scars and the remains of stipules are visible on the surface of the rhizome. If a vertically oriented rhizome is not buried, it can attain the appearance of a miniature tree; a large clone can attain the appearance of a miniature forest. A similar situation is sometimes observed in other *Viola* species e.g. *V. odorata* L. and *V. riviniana* Rchb. If a vertically oriented rhizome is slowly buried with eroded soil, it can survive by elongating vertically, a useful strategy in a geologically unstable environment. All that may be visible at the surface is a rosette of leaves.

Although empirical data are lacking, it is possible that fleshy rhizomes function as water storage organs. Enlarged, subterranean rhizomes were found by the second author in a population of *Viola perreniformis* plants at Crows Nest NP, Qld (**Fig. 2**). Its gourd-like shape suggests it may function as a water and/or nutrient storage organ. Perhaps this rhizome was initially above ground and then subsequently buried; perhaps it was then able

Fig. 2. ***V. perreniformis***. An enlarged, subterranean rhizome; length between arrows is *c.* 22 mm. Crows Nest NP, Qld, Mar 2013. Photo: G. Leiper.

to retain water more efficiently and gradually assumed a gourd-like shape.

Clones of some species can occupy up to 1 m or more in diameter. Although detailed studies of how these species spread via stolons have not been made, the first author recorded preliminary observations of the stages that a single 'mother' plant of *Viola hederacea* went through as it matured and spread over time; a brief description follows. After several leaves in the rosette of the mother plant matured and enlarged, five stolons developed that spread out in all directions. A rosette of miniature leaves formed at the distal end of each elongating stolon. If the stolon tip contacted suitably moist soil, a white, root-like structure developed and grew into the soil. After several days, the leaves in the newly rooted rosette increased in size and simultaneously

several new stolons formed and spread out in all directions and as they elongated, rosettes of miniature leaves formed at the tip of each new stolon. This process was repeated over and over in all directions from the initial mother plant until there was a mass of stolons and leaves *c.* 1 m in diameter. If a node didn't contact moist soil, the stolon continued to elongate, developing rosettes of leaves at each node. Because the available evidence suggests seeds of the four taxa may not be ant dispersed (see below) and they may not produce cleistogamous flowers (see below), vegetative reproduction through vigorous stolon growth may be an important strategy for survival in section *Erpetion*.

Stems. A valuable taxonomic character commonly used to separate *Viola* species in European, North American, and Asian floras, is whether the plant has stems (caulescent) or does not (acaulescent). Stems in caulescent *Viola* species are usually upright structures that originate from a fleshy or somewhat woody rhizome and possess alternating leaves subtended by stipules. Peduncles that produce chasmogamous and in many species, cleistogamous flowers, arise from axillary positions on the stem. In caulescent species in North America, the internode distance is usually short early in the growing season, elongating later in the season. Peduncles in caulescent species are normally produced only from stems and not directly from a rhizome. Caulescent *Viola* species in North America have both basal and cauline leaves, although a few species have only cauline leaves and no basal leaves. When present, basal leaves arise directly from the rhizome and are taxonomically useful in some species. In all *acaulescent* species known outside of Australia, the leaves and peduncles arise directly from a rhizome.

Of interest relative to the foregoing is that all Australian species in section *Erpetion* produce stolons. By analogy with the acaulescent, stoloniferous species in Europe and North America, species in section *Erpetion* would be assumed to be acaulescent. However, the *Viola* treatments in most Australian floras e.g. *Flora of Australia* (Adams 1982b), *Flora of South-East Queensland* (Stanley & Ross 1983), *Flora of New South Wales* (James 1990), *Flora of Victoria* (Entwisle 1996), *Electronic Flora of South Australia* (2007), *Flora of Tasmania Online* (Duretto 2009), and *New South Wales Flora Online* (James 2013), state that stems are present for all species in the section. "Stems short" and "stems short, erect" are common descriptions in these floras for stems of species in section *Erpetion*. Also of interest is that the peduncles of all Australian species in section *Erpetion*, with two known exceptions, appear to develop only from rhizomes produced at a stolon node, similar to acaulescent, stoloniferous species elsewhere in the world. Thus, at present it appears that stems do not normally occur in section *Erpetion*, such as those typically found in caulescent species, e.g. *V. caleyana* Don in Australia.

A remarkable exception was documented by Thiele & Prober (2006) when they reported that *Viola silicestris* often develops "a caulescent growth habit when growing in sheltered sites amongst other vegetation, with elongate, weakly erect, scrambling aerial stems to 30 cm high and scattered leaves. Plants in exposed sites have contracted stems and fasciculate leaves". In northern NSW and Qld, we found stems on *V. silicestris* plants that had developed at stolon nodes and peduncles that developed from axillary nodes on the upright stems. Peduncles may also develop directly from rhizomes at stolon nodes, but this has not been verified. Stems can be short, e.g. 1.5 cm, or greatly elongated, 30–40 cm (Thiele & Prober 2006). The authors found a population in Springbrook NP, Qld, where clearly discernable stems occurred at 6 of 8 nodes on a stolon 75 cm long. At another location in Springbrook NP an 85 cm long stolon had discernable stems at 3 of 10 nodes. It may be that stem development in this species is more common, perhaps overlooked when stems are short and hidden in a rosette of leaves. The development of a *stem* from a *stolon* node has not previously been documented in other *Viola* species known to the authors and may be unique to section *Erpetion*. Acaulescent, stoloniferous species such as *V. odorata* typically root at a node and form a rosette

of leaves similar to the four taxa, but erect stems are never produced by such species at a stolon node. The growth habit of *V. silicestris* may represent a transitional stage from an acaulescent to a caulescent habit.

Viola perreniformis also produces stems. In 2013 the authors found plants with stems in Nightcap NP in NSW (*Little 13697 & Leiper* [BRI]) (**Fig. 3**). In addition, possible evidence of stems have been observed on several herbarium specimens at BRI that were collected in Qld and identified by the authors as *V. perreniformis*. Stems were not observed in populations of *V. perreniformis* at Crows Nest NP or on Mt Edwards (Moogerah Peaks NP) in Qld. Although phenotypically similar, it is possible these populations are genetically different and never produce stems, or stems were produced but overlooked, or perhaps microhabitat conditions precluded stem development.

Thiele & Prober (2006) noted that *Viola hederacea* and *V. sieberiana*, in contrast with *V. silicestris*, *never* (author's emphasis) develop a caulescent growth habit, even when growing amongst dense vegetation. Our observations of herbarium specimens and of living populations of *V. banksii* in Qld have not revealed evidence of stems. In *V. banksii*, *V. hederacea* and *V. sieberiana*, leaves and peduncles appear to arise only from a rhizome and never from a caulescent stem. These observations suggest these taxa could be acaulescent, although additional observations are needed. No data are available for *V. cleistogamoides* or *V. fuscoviolacea* regarding presence/absence of stems.

Leaves. The size and shape of leaves of most *Viola* species can vary greatly due to many factors, such as time of year (spring versus summer), the amount of soil moisture and other edaphic factors, and whether in sun or shade (Little & McKinney in press). Thiele & Prober (2006) appear to have been the first to document similar observations in reference to Australian violets, stating "This is a problem throughout the section, with reduced leaves of all species converging in shape [when immature] while fully developed leaves from sheltered sites are usually highly distinctive". They noted that most herbarium specimens fail to adequately represent the local variation present in leaves of species in section *Erpetion* and that the location of the plant, e.g. sun or shade, can have a profound effect on leaf size. We concur and emphasize that mature, fully developed leaves can facilitate identification of the four taxa. However, plants may have mature leaves that are not fully expressed, i.e. not typical, if they are growing in difficult sites (pers. comm., K. Thiele and observations by the authors). Thus, having fully developed, mature leaves may be essential for identification. In addition, it is necessary to consider all the leaves in a population and not focus on a few variants because in most populations of the four taxa, a few leaves can often be found at different stages of growth that are more typical of one of the other species. Also important to note is that various combinations of the four taxa are sympatric and it is possible that the stolons of two or more species could become intertwined in a given population resulting in some confusion if the leaves of one species

Fig. 3. ***V. perreniformis.*** Pressed specimen showing stem (arrow) arising from a stolon node; 3 peduncles from the stem. Nightcap NP, NSW. Feb 2013. Photo: J. Little.

are associated with the flowers of another.

The leaves of all four taxa are darker green adaxially compared to lighter coloured abaxial surfaces (**Fig. 4**). The overall outline of *Viola banksii* and *V. perreniformis* leaves remain ± proportionally constant during development from immature to fully developed, whereas the leaves of *V. hederacea* and *V. silicestris* expand laterally as the blade matures, with the blade becoming much wider than long.

The information in **Table 1** is an attempt to qualitatively summarize and contrast morphological leaf characters in the four taxa typically found in fully developed leaves. Some characters for a given species appear genetically fixed and do not vary, e.g. fully developed *Viola silicestris* leaves never have an orbicular outline; the outline of *V. banksii* and *V. perreniformis* leaves are never ± rectangular and their shapes are never falcate; a distinct sinus never occurs in fully developed *V. hederacea* or *V. silicestris* leaves, etc. As noted in the table, other morphological characters are only 'sometimes' present in a given leaf or population. 'Usually' in the table indicates the norm for the species, recognizing that variation occurs in that character. Immature leaves of some species have characters associated with fully developed leaves of other species (see discussions below).

Table 1. Qualitative summary of some leaf characters typically found in fully developed leaves of some *Viola* species

Leaf characters	*V. banksii*	*V. perreniformis*	*V. hederacea* subsp. *hederacea*	*V. silicestris*
outline orbicular	usually	sometimes	no	no
outline ovate	no	sometimes	no	no
outline ± rectangular	no	no	sometimes	sometimes
outline semi-circular	no	sometimes	usually	no
shape distinctly reniform	sometimes	usually	no	no
shape sub-reniform (i.e. cordate lobes not well developed)	no	sometimes	sometimes	sometimes
shape falcate	no	no	no	sometimes
leaf margins crenate from base near petiole to apex	no	usually	no	no[1]
leaf base cordate	yes	usually	no	no
leaf base truncate	no	sometimes	usually	usually
distinct basal lobes present	yes	usually	no	no
distinct sinus present formed by lobes	yes	usually	no	no
leaves much wider than long	no	no	yes	yes

[1]The distal leaf margins of *V. silicestris* are occasionally ± crenate, but the basal part of the blade is never crenate.

***Viola banksii*:** Mature leaves ultimately attain an ± orbicular outline and shape or sometimes a reniform shape. The apex of mature leaves is usually truncate or rounded; a distinct mucro at the apex of the midvein is sometimes present; the base is cordate, never truncate. The two distinct basal lobes often overlap in fresh material, but overlapping lobes can be obscured when pressed. As the leaf matures and expands, the marginal teeth become further apart and often become small and less obvious on the upper half of the leaf. The margin is occasionally ± dentate. Occasionally small teeth and/or 3 or 4 small lobes (crenations) are present on the lower half of the leaf, but never around the entire margin. Mature, orbicular-shaped leaves are about as wide as long; reniform-shaped leaves are slightly wider than long. In small, immature leaves a distinct sinus is often present. A distinguishing characteristic of this species is the tendency for the apex of fully developed leaves to be truncate or somewhat rounded while also having cordate basal lobes and a distinct sinus (**Fig. 4**).

Fig. 4. *V. banksii*. Sequence of development from new (1) to fully developed leaf (8). The smallest leaves often have a distinct sinus. Adaxial surfaces are shown; abaxial in 7. Pilose pubescence present on leaves and petioles. Photo: J. Little.

Viola hederacea subsp. ***hederacea*:** Mature leaves have been described as broad-reniform or semi-circular, usually truncate at the base and a margin with 8–16 teeth, the base occasionally with a broad sinus or broadly cuneate (Thiele & Prober 2003). Images of the type specimen show many small and large leaves with a distinct cuneate base. We found blade outlines of fully developed leaves to be ± rectangular (**Fig. 5.8**). Leaf apices are variable, rounded, obtuse, truncate, or occasionally convex. When the apex is truncate or convex, the outline is arguably not semi-circular, but closer to rectangular. The terminal midvein is usually just a small point or mucro. The distal (upper) leaf margin is ± entire with only a few short points where the major veins terminate. The base of fully developed leaves is usually

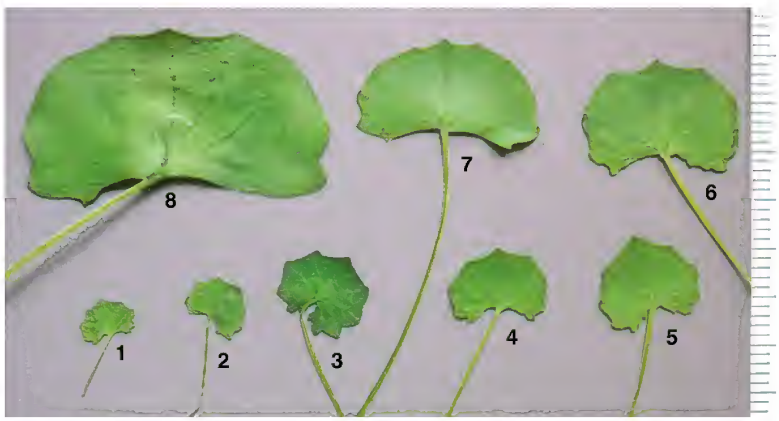

Fig. 5. *V. hederacea*. Sequence of development from new/immature (1) to fully developed leaf (8). Basal angle increases with age until becoming truncate in fully developed leaves. Adaxial surfaces shown. Photo: J. Little.

truncate and does not form distinct lobes as in *V. banksii* or *V. perreniformis*. Occasionally, the basal blade margin is curved or arched downward between the petiole attachment and the outermost edge of the blade, similar to *V. silicestris*. Such leaves are sometimes described as having a 'wide' sinus. The basal margin of young and fully developed leaves is entire or may have a small point or two and often forms a ± straight line between the petiole attachment and the outer edge of the blade. The angle formed by the leaf base in fully developed leaves is obtuse to usually truncate (180°).

Distinguishing features in fully developed leaves separating *Viola hederacea* (**Fig. 5.8**) from *V. banksii* and *V. perreniformis* are a truncate leaf base and lack of a sinus. Fully developed leaves of *V. hederacea* are somewhat similar to *V. silicestris* in that both can be ± rectangular and are much wider than long. Immature *V. hederacea* leaves usually have small lobes, but as the leaf matures and enlarges, the angle between the lobes gradually increases and the lobes 'disappear' as the base becomes truncate. Occasionally, small, immature leaves of *V. hederacea* have very distinct lobes and a distinct sinus and are very similar to immature leaves of other species, e.g. compare **Figs. 4.5, 5.3, 6.1**.

Our observations of herbarium and living specimens of *Viola hederacea* suggest that leaves that match the description of "broad-reniform" are not fully developed or perhaps were growing in difficult sites. The lobes in broad-reniform leaves are small (=sub-reniform) and the width of such blades are smaller compared to a fully developed leaf. The typical leaf shape of *V. eminens* was described as "broad-reniform" (Thiele & Prober 2003); however, we have not studied this species and our observations that broad-reniform leaves are not fully developed pertain only to *V. hederacea*. Although *V. hederacea* subsp. *hederacea* was reported to be replaced in Qld by *V. hederacea* subsp. *perreniformis* (Thiele & Prober 2003), many populations have been found in Qld that morphologically match the description of *V. hederacea* and are considered by the authors and others to be *V. hederacea*. The second author has found several populations in Qld where the flowers are somewhat similar to *V. hederacea*, but the leaves are cordate or reniform with distinct basal lobes.

***Viola perreniformis*:** Outlines of fully developed leaves are ovate, orbicular, suborbicular, or semicircular; their shapes are reniform or ovate. The apex is acute, obtuse, or rounded, occasionally ± truncate. The base of mature and immature leaves is usually cordate with a distinct sinus formed by the lobes of the blade. The sinus is usually distinct, but wider than in *V. banksii*. Most populations of *V. perreniformis* in Qld occasionally have some truncate and/or subtruncate leaf bases in addition to typical leaves with cordate bases, but these are usually associated with immature leaves. The marginal crenations (lobes) are usually quite uniform, but can be somewhat 'ragged' and irregularly shaped in some populations. Although the number of crenations per blade can vary in the same clone and among different populations, distinct crenations are present on most leaves in a clone. The number of crenations on one side varies from four in small/immature leaves to nine (seldom ten) in the largest/fully developed leaves. Fully developed leaves are usually slightly wider than long. Distinguishing features are leaves with crenate margins, usually around the entire blade in fully developed and usually also in immature leaves (**Fig. 6**).

Fig. 6. ***V. perreniformis***. Sequence of development from immature (1) to fully developed leaf (5). Leaves at all growth stages are lobed. Adaxial surfaces shown. Photo: G. Leiper.

***Viola silicestris*:** Fully developed leaves have been described as broad, occasionally sub-reniform, the margin with (5–)7–12(–14) obscure teeth, the apical tooth not prominently larger than the rest (Thiele & Prober 2006). Here, we describe the overall outline of a fully developed blade as broad or ± rectangular, often with a falcate shape and occasionally sub-reniform. When falcate, the upper and lower margins are parallel. Occasionally a leaf is found with a shape resembling the tail of a diving whale. The apex is often truncate, sometimes rounded; the terminal midvein usually not much longer than the two adjacent veins, but sometimes shorter. The terminal midvein is usually just a small point or mucro. The blades are not distinctly lobed and a distinct sinus is not present. The base of fully developed leaves is truncate, although sometimes slightly curved or arched downward between the petiole attachment and the outermost edge of the blade. Occasionally, the blade bases curve upward from the petiole. The basal margin is entire or may have a small point or two. The distal leaf margin is ± serrate, subserrate, sometimes denticulate, or occasionally ± crenate. The outline of immature leaves is semi-circular or sub-reniform, smaller leaves are sometimes ± ovate; the apex obtuse or acute; the upper margin serrate, subserrate, or ± denticulate, the leaf base attenuate (cuneate) in some populations and truncate in others. Distinguishing features of this species are leaves that are usually much wider than long through all stages of growth from new/immature to fully developed. Fully developed leaves have a ± rectangular outline or falcate shape and never have distinct lobes or a sinus (**Fig. 7**).

Fig. 7. ***V. silicestris***. Sequence of development from immature (1) to fully developed leaf (5). Leaves are much wider than long at all growth stages. Adaxial surfaces shown. Photo: G. Leiper.

Indumentum

***Viola banksii*:** This species was described as glabrous (Thiele & Prober 2003). However, several specimens at BRI collected in Qld have pilose hairs on adaxial, or on adaxial and abaxial leaf surfaces (e.g., BRI [AQ11278], [AQ115406]). A number of other populations in Qld appear to be *V. banksii* based on leaf shape, but the plants were variously pubescent on one or both surfaces, or leaves and petioles were densely pubescent (**Table 2**). *V. banksii* plants are sold commercially worldwide under the name "*Viola hederacea*" (Thiele & Prober 2003; Elliot & Jones 2010). The first author has maintained a clone of *V. banksii* for over 10 years purchased as "*Viola hederacea*" from a nursery in Sacramento, California, U.S.A. The leaves, petioles, and peduncles on this clone are usually pubescent (**Fig. 4**), similar to some of the populations noted in **Table 2**. When leaves of *V. banksii* are pubescent, the margins are usually ciliate, as in *V. perreniformis*. Based on our observations of pubescence on *V. banksii*, we believe this character state needs to be recognized in descriptions of this taxon. Further study is needed of the populations noted in **Table 2**.

Viola hederacea subsp. ***hederacea*:** Leaves were described as glabrous or with scattered unicellular hairs on the upper surface (Thiele & Prober 2003). Our observations of populations in southeast Qld and northern NSW are similar, although we have observed scattered hairs are sometimes present on both leaf surfaces. In addition, this species occasionally has hairs proximally on petioles and peduncles. In comparing the leaves of this taxon with *V. silicestris*, a general tenet is that *V. hederacea* leaves are often short-hairy, at least on adaxial surfaces, whereas *V. silicestris* leaves are usually glabrous.

***Viola perreniformis*:** Adams (1982b) stated that leaves of this species were softly pubescent, rarely almost glabrous. The authors

Table 2. Populations of pubescent *Viola banksii* cf. in Queensland

Location in Queensland	Comment
Pine Ridge CP and Jacobs Well (Gold Coast coastal areas)	Plants appear to be *V. banksii*. At both locations leaves have scattered hairs; at Jacobs Well, petioles are hairy.
Point Cartwright (Sunshine Coast)	Plants appear to be *V. banksii*. Leaves are sparsely hairy.
Alexandra Headland (Sunshine Coast)	Plants appear to be *V. banksii*. Leaves and petioles are very hairy.
Maroochy River CP (Sunshine Coast)	Plants appear to be *V. banksii*. Leaves with scattered hairs on both surfaces.
Ningi (Abbey Museum at the southern end of the Sunshine Coast)	Plants appear to be *V. banksii*. Leaves with scattered hairs on both surfaces.

conducted a brief evaluation of pubescence on leaf surfaces, petioles, and peduncles among *V. perreniformis* populations in Qld and NSW. The evaluation revealed substantial variation in pubescence on the same plant, between plants in the same population, and among different populations. Most populations were sparsely to densely pubescent on both leaf surfaces although the density of hairs usually varied between the abaxial and adaxial surfaces on the same leaf. Some populations had both glabrous and pubescent leaves on the same plant. Leaf margins were ciliate or eciliate. The petioles and peduncles of most populations were sparsely or densely villous, although some populations had both glabrous and pubescent petioles and peduncles on the same plant. No population was completely glabrous, although a population at Crows Nest NP in Qld was almost completely glabrous, with scattered pilose hairs only on the cordate lobes of the adaxial leaf surfaces. The pubescence on the abaxial surface of smaller leaves on the type specimens is considered tomentose, but larger leaves are considered densely pubescent. Based on our observations, we conclude the *absence* of hairs on leaves, petioles, and/or peduncles is not taxonomically useful. However, the *presence* of dense pubescence on leaves, petioles, and/or peduncles can be helpful for identifying *V. perreniformis* if appropriate leaf shapes and flower colours are also present. When leaves of *V. perreniformis* are pubescent, the margins are normally ciliate, as in *V. banksii*.

***Viola silicestris*:** Leaves of this species were described as glabrous or occasionally sparsely short-pubescent when young (Thiele & Prober 2006). Our observations of populations in southeast Qld and northern NSW are similar. The basal margins of young leaves on plants in Nightcap NP, NSW, occasionally had marginal cilia, but were otherwise glabrous. Many leaves on the isotype at BRI are ciliate (*Thiele 2568* [BRI]).

***Flowers. Petal movements and petal twisting*:** The two upper petals of the four taxa are sometimes described as "petals erect or reflexed". Reflexed upper petals and twisted lateral petals are common traits among the four taxa. Both authors have independently observed that petals of *Viola banksii* reorient themselves into a 'sleep' mode at dusk, then 'reopen' the next day. For example, as dusk approaches, the two completely reflexed upper petals of *V. banksii* flowers fold *forward* over the front of the flower (a movement of *c.* 180°) and the lateral petals 'untwist' and extend straight out in front of the flower. In the morning of the next day, the upper petals reflex *backward* (another *c.* 180°) from their forward position and the lateral petals spread back laterally to their normal daytime position and become twisted. Thus, the upper petals are 'erect' only for a brief period twice a day

Fig. 8. ***V. perreniformis***. Erect upper petals; all petals pale blue-violet with violet-coloured blotches on upper and lateral petals. Moogerah Peaks NP, Qld. 2013. Photo: G. Leiper.

(Fig. 8), at least for the first few days after the flower first opens. Initial observations indicate that after several days, the petals no longer exhibit these nyctinastic movements. The first author and W. Cherry (pers. comm.) have independently observed nyctinastic petal movements in flowers of *V. silicestris*. This phenomenon is not known to have been previously documented in section *Erpetion* and its occurrence elsewhere in the section is unknown.

***Flower colours*:** Flowers of *Viola perreniformis* and *V. silicestris* have been described as "concolorous" whereas flowers of *V. banksii* and *V. hederacea* have been described as "discolorous" (=bicoloured). Concolorous is also applied to the flowers of *V. cleistogamoides*, *V. fuscoviolacea* and *V. sieberiana*. The term concolorous in reference to the overall appearance of a flower is useful as an initial assessment to determine the species at hand, e.g., *V. perreniformis* versus *V. silicestris*. However, because the face of *V. perreniformis* flowers often has darker coloured blotches on the upper and lateral petals, darker veins on the lowest and sometimes all petals, and because the petal bases are white, the description as 'concolorous' is sometimes not so clear cut.

The description of flower colours on collection labels can assist with taxon identification, but can be problematic for future researchers if ambiguous. For example, flower colours recorded for specimens we would consider *Viola perreniformis* based on leaf shape include the following descriptions: flowers pale blue; flowers purple; flowers sky blue; flowers violet with darker purple marks; flowers white and purple streaked; lilac-white flowers; mauve and white petals; violet flowers. None state whether the petal tips are white or not. Because the patterns of colouration on the face of flowers in the four taxa can be complex and because colours facilitate identification, we suggest 1) that names for flower colours, veins, and blotches be based on a readily available standard, and 2) that separate descriptions be recorded by the collector for the colour, presence or absence of darker coloured blotches, and presence or absence of darker coloured veins, for the upper and lateral petals, and for the lower (anterior) petal. For all petals, whether the tips are white or not should also be recorded.

The colours on petals of *Viola* flowers fade rather quickly on herbarium sheets and if not quickly pressed flat, the petals shrink and become distorted. These factors can make it difficult or impossible to determine the original colour scheme and/or petal shape on herbarium specimens. For example, within a month after collecting *V. perreniformis* and *V. silicestris* flowers, the distal portions of the petals, which had been pale blue when fresh, had faded in the press to a whitish colour.

Viola banksii and ***V. hederacea*** subsp. ***hederacea*:** Flowers of *V. banksii* were described as strongly discolorous violet-and-white (Thiele & Prober 2003). Flowers of *V. hederacea* were described as usually discolorous violet-and-white (occasionally concolorous pale violet or almost white),

the colours usually not strongly demarcated (*ibid.*). In general we concur with these descriptions, although some populations in Qld that appear to be *V. banksii* based on leaf shape have flowers that are not strongly demarcated and other populations that appear to be *V. hederacea* have flowers that appear to strongly demarcated. Among the possible explanations is that a greater range of variation needs to be recognized, or perhaps new taxa are involved.

***Viola perreniformis*:** Adams noted that petal colours of *V. perreniformis* were pale (lazuline) blue-violet. We concur and have observed the abaxial surfaces of the five petals (**Fig. 9**) and portions of the adaxial surfaces (i.e., the 'face') are usually a pale blue-violet colour (**Figs. 8, 10**). The adaxial surfaces often have distinct purple blotches of various sizes on the lateral petals and occasionally basally on the upper petals (**Fig. 8**). In addition, faint to very distinct violet-coloured veins are often present on both surfaces of the lateral petals and lowest petal. The proximal portions on the adaxial surface of the upper and lateral petals are usually white, although it may be difficult to detect in some flowers without manually spreading the petals. The lowest petal is white proximally, blue-violet distally, and always has distinct, darker, violet-coloured veins (nectar guides). We observed substantial variation in the amount of pigmentation present on the 'face' of *V. perreniformis* flowers at Crows Nest NP, Moogerah Peaks NP and Nightcap NP.

***Viola silicestris*:** Flowers were described as concolorous pale mauve-blue (rarely somewhat discolorous) (Thiele & Prober 2006), similar to our observations. At Springbrook NP, the authors found populations growing on rhyolite which had completely white flowers. These flowers did not have any darker coloured veins (i.e., no nectar guides) abaxially or adaxially on the upper, lateral, or lower petals.

***Venation (nectar guides) on lowest petal*:** Venation of the lowest petal was determined to be a useful taxonomic character for distinguishing *V. banksii*, *V. hederacea*, and *V. silicestris* (Thiele & Prober 2003, 2006). We found general congruence with the venation pattern described for these species in some populations, but not in others.

Fig. 9. Abaxial surface of ***V. perreniformis*** flowers wtih concolorous petals. Note the green and white indurate area at base of lowest petal (arrows). Crows Nest NP, Mar 2013. Photo: G. Leiper.

Fig. 10. ***V. perreniformis***. Upper petals fully reflexed, lateral petals twisted. Crows Nest NP, May 2013. Photo: G. Leiper.

***Green and white indurate area*:** A small, 1–2 mm long, 1–2 mm wide, green and white area is located at the proximal end of the lowest petal of the four taxa (**Figs. 9, 11**). A narrow, white, crescent-shaped zone usually occurs between the coloured part of the petal and the green area. A similar green and white area has been reported in *V. eminens* and is referred to as a "small green blotch" or "V-shaped blotch" in these species (Thiele & Prober 2003, 2006). *V. cleistogamoides* also has a green and white area on the lowest petal (Thiele & Prober 2006), but *V. fuscoviolacea* does not (Thiele & Prober 2003). No information is available for *V. sieberiana*. In addition to the colour being distinctly different from the rest of the petal,

Fig. 11. ***V. banksii***, face view, lateral and upper petals removed. Yellow arrows point to anther glands. Green and white indurate area (not in focus) in lowest petal indicated by white arrow. Photo. J. Little.

we found the tissue in the green and white area in *V. banksii* and *V. perreniformis* flowers to be slightly 'harder' (indurate) compared to the rest of the petal, a feature not previously reported for flowers in section *Erpetion*. In flowers of *V. banksii*, *V. hederacea*, and *V. perreniformis*, we also observed a small green area at the base of the two lateral petals similar in colour to the indurate area on the lowest petal, a feature not previously reported in other species in section *Erpetion*. It has not been determined if the green area on the lateral petals is indurate compared to the rest of the petal. Although it may be presumed that the green and white indurate area in some way facilitates pollination and/or pollinator attraction, its purpose or function is unknown. When a flower is held up to a light source, the centre of the indurate area is translucent, perhaps functioning as a 'window' for the benefit of a pollinator. The lowest petal of most *Viola* flowers has the same texture throughout their length. For example, an indurate area at the base of the lowest petal was not reported for any of the 96 *Viola* species in China (Chen *et al.* 2008), nor any of the 73 *Viola* species in North America (Little & McKinney in press), and may be unique to species in section *Erpetion*.

***Style*:** The style of the four taxa is similar: a thin, straight, ± terete structure, except angled downward near the distal end toward the lowest petal; the style head is glabrous. The base of the style in the four taxa is geniculate near the attachment to the ovary, similar to many *Viola* species. The geniculate base facilitates the style shaft being easily moved when 'pushed aside' by insects probing for nectar or pollen. The geniculate portion of the style functions as a spring, allowing the style to be easily moved by the pollinator. After the pollinator withdraws, the style returns to its original position. In some *Viola* species in Europe, when the style is lifted up by a probing insect the anthers are spread apart and pollen is released (Beattie 1974).

***Anther glands*:** The term 'anther gland', apparently first used by Thiele & Prober (2003), is an accurate and appropriate name for the glands found in the four taxa. Compared to the appendage and nectary found in many *Viola* species, the morphology and presentation of the anther glands in the four taxa are totally different. A few differences are highlighted. First, because the flowers have no spur, the anther glands are not protected within one; second, the anther glands develop laterally from and do not extend beyond the base of the anther; third, the nectaries in most *Viola* species are situated adjacent to each other whereas in the four taxa the anther glands are widely separated. In his description of the genus *Viola*, Adams (1982) stated that the anterior two anthers have "basal appendages" i.e., outgrowths from each anther, the distal portion of which secretes nectar. Although correct for species in which the two nectaries extend into a spur, e.g. *V. betonicifolia* and *V. caleyana*, it is inaccurate for the four taxa in section *Erpetion* because the anther glands are never longer than the anther and the nectaries are not enclosed in a spur.

When a flower is viewed face on with a hand lens, the two anther glands in flowers of the four taxa are seen 'hanging down' like landing gear on a plane (**Fig. 11, 12**). Remarkably, because the anther glands are not protected within the confines of a

spur, they are 'exposed' to the elements and potentially, it would seem, to physical damage from pollinators. Because the anther glands are situated above and immediately adjacent to the indurate portion of the lowest petal, one might assume that nectar would pool in the concavity formed by indurate area. However, we have not observed nectar in fresh flowers of the four taxa and are not aware of data demonstrating that nectar is produced in these species. In photographs of anther glands from freshly collected flowers of *Viola banksii*, *V. hederacea* and *V. perreniformis*, the glands were often 'glistening,' but obvious liquid nectar was not present. The lack of observations of nectar is not, of course, evidence that none is produced. Perhaps because they are not protected within a spur, the anther glands in section *Erpetion* have a different function other than to produce nectar. Pollen has been observed adhering to the anther glands in the four taxa presumably due to secretion of a viscid exudate.

The shape, colour, and surface texture of the anther gland is a useful diagnostic feature in section *Erpetion* (Thiele & Prober 2003). **Table 3** summarizes information for anther glands reported in the literature. **Table 4** summarizes preliminary observations made by the authors. The green colour of glands in some species is very similar to the colour of the indurate area of the lowest petal. The glands of some species are reported as pale or dull green or whitish. However, it is unknown if the colour is initially green and transitions to white or whitish over time, or vice-versa, or if some flowers typically produce only one colour, or if the gland is sometimes or always ± bi-coloured (e.g. white or pale distally, green proximally). A similar situation exists for gland surface texture. In a brief comparison of newer versus older flowers of *Viola banksii*, the first author found that glands of both newer and older flowers were white or whitish and both were rugose. However, the glands of this species have also been reported as pale green and smooth (**Tables 3 & 4; Fig. 12**).

The anther glands of *Viola silicestris* were described as "irregular, narrow" and an illustration shows them to be sinuous (Fig. 1 in Thiele & Prober 2006). However, in a population we sampled in Qld, the glands were prominent and curved, not narrow and sinuous. We believe that differences reported for shape, surface texture, and colour among the four taxa suggests that additional observations are needed. *V. hederacea* sometimes has purplish glands (Thiele & Prober 2003). A pure white flower of *V. silicestris* from Springbrook N.P. was found without an anther gland on either of the two lower anthers. A critical survey is needed of the morphology and development of anther glands, the role they play in reproductive biology, and a standard terminology developed for species in section *Erpetion*.

Fig. 12. ***V. banksii***. Lateral view of one of the two anther glands (arrow). Lateral and upper petals removed. Photo: J. Little.

Pollination and cleistogamy. With certain exceptions, most species in the section have relatively large, showy flowers. Comparably sized flowers of *Viola* species in the northern hemisphere attract a wide range of insect pollinators such as solitary bees, bee-flies, syrphid flies and various Lepidoptera including butterflies and skippers. Beattie (1971) documented 43 different insect species in a *Viola* pollination study in England. The authors have not observed potential pollinators visiting flowers of any of the four taxa, although pollination of chasmogamous flowers is assumed to occur based on the many developing and dehisced capsules present in most populations and the fact that seeds are produced.

The fully reflexed upper petals of the four taxa could be an adaptation that facilitates sternotribic pollination by providing a platform on which insects can land. Sternotribic pollination occurs when an insect enters a flower 'upside down,' in contrast with nototribic pollination where the insect enters the flower in a supine position (i.e. 'right side up') (Beattie 1974).

Typical *Viola* pollinators seek nectar and/or pollen, although some are only after pollen. The authors have observed copious amounts of pollen in fresh flowers of each of the four taxa. A pollination study conducted with two *Viola* species in Brazil provided evidence that both species may be shifting from flowers that typically produce nectar, to flowers that provide primarily pollen (Freitas & Sazima 2003). The first author has observed yellow-coloured thrips (Thysanoptera) with pollen adhering to their bodies in *V. banksii* flowers, randomly and rapidly moving over and within dehisced anther sacs and around the ovary. Thrips were reported in *Viola* flowers (Baker 1935) and the first author has also observed them on flowers of several *Viola* species in California. Although thrips are often observed with pollen attached to them, there is currently no evidence they play a role in pollination of *Viola*. However, due to numerous observations of thrips in *Viola* flowers, it seems highly probable they could periodically affect pollination.

Cleistogamy occurs in many species of *Viola* throughout the world and is interpreted as a mechanism to help ensure survival when pollinators are unavailable. In North America, *c.* 85% of all species are known to produce cleistogamous (CL) flowers; only nine species are known to never produce CL flowers (Little & McKinney in press). In Asia, CL flowers are very common in most *Viola* species (J. Leng, pers. comm.). The presence or absence of CL flowers is not mentioned in Australian floras for any species of *Viola*. The authors have not observed CL flowers in the field or

Table 3. Summary of anther gland characters reported in the literature for *Viola*

Species/Source	Description	Surface Texture	Colour
V. banksii[1]	long, narrow and high, scarcely flattened	smooth	pale green to whitish
V. hederacea subsp. *hederacea*[1]	shorter than the anther cells, broad at the base and each distinctly flattened or depressed towards the other; short, rugose, often purple	irregularly rugose	purplish or dull green
V. silicestris[2]	slightly shorter than the anther cells, irregular, narrow	(Not reported)	pale

[1]Thiele & Prober 2003.

[2]Thiele & Prober 2006.

Table 4. Summary of anther gland characters recorded by authors

Species/Source	Description	Surface Texture	Colour
V. banksii Springbrook NP, Qld[1]	anther gland prominent, 'tall' or 'high', almost as long but not as wide as anther, wider proximally, slightly curved, 'top' of gland ± flat	smooth	pale green basally, ± greenish-white distally
Venman Bushland, NP, Qld	anther gland not prominent, short, *c.* ½ length of and not as wide as anther, gland height 'short', not 'tall' or 'high', appears ± 'flat' entire length of gland	smooth	white or whitish with a greenish tinge
Plant sold in U.S.A. as "*V. hederacea*"	anther gland prominent, 'tall' or 'high' almost as long but not as wide as anther, much wider proximally, curve, 'top' of gland ± flat	rugose	white or whitish or pale green entire length
V. hederacea subsp. *hederacea* Springbrook NP, Qld	anther gland prominent, almost as long and about as wide as the anther, gland is wider proximally, arched (curved), taller distally	at lower magnifications, the gland appears irregularly rugose; at higher magnifications the surface appears smooth; the uneven, rugose appearance appears to be caused by clumps of pollen grains adhering to the glandular exudate; the normally white pollen grains then take on a greenish colour	pale green basally, ± whitish distally; sometimes glistening when fresh
V. perreniformis	anther gland prominent, c. ½-⅔ as long as anther	smooth	pale green
V. silicestris Springbrook NP, Qld	anther gland prominent (on a violet-tinged anther), almost as long as, but narrower than the anther, proximal portion curved toward other gland	not determined	yellowish to pale

[1]Possibly a horticultural escape.

on herbarium specimens of the four taxa, nor on *V. sieberiana*. Cleistogamous flowers have not been observed on herbarium specimens of *V. cleistogamoides* or *V. fuscoviolacea* (the authors have not observed these species in the field). However, detecting CL flowers on herbarium specimens is difficult because CL flowers can appear similar to undeveloped or aborted chasmogamous flowers.

Viola species exhibit numerous strategies that promote reproductive fitness, one of which is hybridization that results in the formation of amphiploids, diploids, and tetraploids. As the authors have found and others have reported (Thiele & Prober 2006), some of the four taxa and other species in section *Erpetion* are sympatric. For example, in NSW sympatric populations occur with *V. perreniformis* and *V. silicestris*; *V. hederacea* and *V. silicestris*; and *V. fuscoviolacea*, *V. sieberiana* and *V. silicestris*; and in Qld, *V. hederacea* and *V. silicestris*. However, among the five species mentioned, no hybrids have yet been found (Thiele & Prober 2003, 2006). An example demonstrating that hybridization can potentially occur in section *Erpetion* was reported in Victoria between *V. eminens* and *V. fuscoviolacea* when an apparently sterile, but vegetatively vigorous putative hybrid, *V.* × *zophodes*, was found (Thiele & Prober 2003).

Adams (1982a) noted in the key to subspecies of *Viola hederacea* that subsp. *fuscoviolacea* L.G.Adams (=*V. fuscoviolacea*) was faintly scented. No other information on floral odours of species in section *Erpetion* is known to the authors.

Seeds and seed dispersal. Seeds of the four taxa, like most *Viola* species, have an ovoid outline, a shape that is assumed to facilitate ballistic travel after ejection from a capsule valve. The seeds of many *Viola* species possess an outgrowth, called an elaiosome or caruncle that develops around and extends out from the micropyle. Elaiosomes are fleshy food bodies of variable size that can be attractive to ants. Although the number of seeds examined in this study was limited, an obvious elaiosome was not detected on mature, recently collected seeds of three of the four taxa nor on *V. sieberiana* (seeds not available for *V. banksii*). Seed characters reported in the literature and observed by the authors for the four taxa and *V. sieberiana* are summarized in **Table 5**. The seeds are small, 1–2 mm long, although *V. banksii* seeds are sometimes up to 2.5 mm long (Thiele & Prober 2003). While the first author was studying seeds of *V. sieberiana*, initial observations suggested that mature seeds were reddish-brown, until shiny black seeds were found. At least for this species, it appears that a reddish-brown colour transitions into black.

The apparent lack of an elaiosome in three of the four taxa and *Viola sieberiana* might lead one to suspect their seeds are not dispersed by ants. However, seeds of a *Viola* species in Europe with almost no elaiosome were reported to be removed by ants (Beattie & Lyons 1975). Lengyel *et al.* (2010) estimated that over 70% of Violaceae species throughout the world are myrmecochorous.

Based on numerous observations of dehisced capsules split into three valves on herbarium specimens and in the field, the dispersal mechanism of seeds from capsules in the four taxa and other species in section *Erpetion* is assumed to be similar to *V. betonicifolia* (Little & Leiper 2012). However, studies are needed to determine ballistic dispersal distances and to determine if ants play any role in dispersing seeds.

Taxonomic challenges

There is considerable evidence that *Viola* populations exhibit character divergence among local colonies of single species (Beattie 1976). It should therefore not be too surprising to find morphological variation among isolated populations of species in section *Erpetion*. Thiele & Prober (2003) noted there are several undescribed species in the *V. hederacea* complex in NSW. Recognition of new taxa may help resolve situations where observed character states in a population conflict with the current taxonomy of the complex. Additional study of the four taxa may reveal other morphological characters or relationships between characters that provide additional or better approaches for taxonomic

Table 5. Seed characters of five species in *Viola* section *Erpetion*

Species/ Location & Source	Mature Seed Colour	Surface Texture	Seed Length
V. banksii[1]	glossy purplish-black	± smooth to irregularly rugose	1.8–2.5 mm
V. hederacea subsp. *hederacea*[1]	dull, mottled cream and brown (occasionally uniformly reddish-brown)	± smooth	1.2–2.0 mm
Springbrook NP[2]	reddish-brown	warty-rugose	1.7–1.8 mm
V. perreniformis[2] Nightcap NP, NSW	shiny or dull dark brown mottled with patches of light brown or tan	uneven to irregularly rugose	1–1.2 mm
V. sieberiana[2]	shiny black	warty-rugose	1.5–1.8 mm
V. silicestris[3]	glossy purplish-black	not reported	1.5–1.7 mm
Springbrook NP[2]	shiny black	warty-rugose	1.6–1.7 mm

[1]Thiele & Prober 2003.

[2]Current authors.

[3]Thiele & Prober 2006.

recognition. Relationships in section *Erpetion* are largely unknown and will probably require DNA sequencing and chromosome counts to elucidate taxonomic relationships (Thiele & Prober 2006).

The provisional keys provided herein are based on the authors' observations and information in Thiele & Prober (2003, 2006). Among the four taxa, the flowers of *Viola perreniformis* are most similar to *V. silicestris*; flowers of *V. banksii* are most similar to *V. hederacea*. Fully mature leaves of *V. banksii* are in general more similar to *V. perreniformis*, whereas leaves of *V. hederacea* are in general more similar to *V. silicestris*.

Provisional Key to selected species in *Viola* section *Erpetion* (based on flowers and seeds)

1 Abaxial surfaces of all petals usually of one colour (concolorous), entire surface pale violet, pale blue, or pale lavender, whitish or pale coloured proximally; on adaxial surface (face), *c.* half of upper and lateral petals pale violet or pale blue distally; (abaxial and adaxial surfaces of *V. silicestris* rarely mostly or entirely white); lowest petal obovate to oblong **2**

1. Abaxial surface of all petals usually of two colours (bi-coloured, or discolorous), petals white distally and pale violet proximally (*c.* 2/3 of upper petals white distally, pale violet proximally) on adaxial surface (face) *c.* 2/3 of upper petals white distally, violet proximally; *c.* half of lateral petals white distally, violet proximally; lowest petal obovate, elliptic, or circular **3**

2 Anthers cream-coloured; fully mature seeds shiny or dull dark brown, 1–1.2 mm long . . . . . **V. perreniformis**
2. Anthers violet-tinged; fully mature seeds shiny black, 1.5–1.7 mm long . . . **V. silicestris**

3 Anther gland smooth or rugose, white or whitish to pale green; the midvein and the two adjacent veins on lowest petal usually prominent and distinct, often without interconnecting 2° veins; the violet and white areas on petals usually strongly demarcated . . . . . **V. banksii**
3. Anther gland usually rugose, dull green or purplish; the midvein on lowest petal often less distinct than the two adjacent veins, often with several to many 2° veins connecting them; the violet and white areas on petals usually not strongly demarcated . . . . . **V. hederacea**

Provisional Key to selected species in *Viola* section *Erpetion* (based on mature, fully developed leaves)

1 Leaf base usually cordate, sinus and lobes usually present, sometimes overlapping, blades about as wide as long (< 2× wider than long), blade outline ovate, orbicular, suborbicular, or semi-circular, blade shape orbicular, reniform, or ovate **2**
1. Leaf base usually truncate, sinus and lobes not present, blades usually much wider than long (> 2× wider than long), blade outline semi-circular or ± rectangular, blade shape broad-reniform or sub-reniform (but lobes not prominent), or falcate (with the upper and lower margins parallel) **3**

2 Leaf margin not crenate from basal lobes to apex, margin nearly entire, sometimes ± scalloped or sinuous, outline usually orbicular, blade shape orbicular or reniform, base cordate, lobes often overlapping in fresh material, apex ± truncate, rounded or obtuse, occasionally ± dentate, the midvein usually not extending much beyond the length of adjacent veins, both leaf surfaces glabrous or with scattered, short hairs, never tomentose, leaf blades about as wide as long . . . . . **V. banksii**
2. Leaf margin regularly or irregularly crenate from basal lobes to apex, outline ovate, orbicular, suborbicular, or semicircular, blade shape reniform, sub-reniform, or ovate, base cordate, lobes seldom overlapping in fresh material, apex usually acute, not truncate, midvein usually extending beyond length of adjacent veins, both leaf surfaces often softly hairy, occasionally tomentose, rarely sub-glabrous; leaf blades usually slightly longer than wide . . . . . **V. perreniformis**

3 The distal (upper) blade margin ± entire or with only a few short points; stems not known to occur at stolon nodes . . . . . **V. hederacea**
3. The distal (upper) blade margin ± serrate or subserrate, sometimes denticulate, occasionally ± crenate; apex often truncate, sometimes rounded; stems (1.5–40 cm) sometimes present at stolon nodes . . . . . **V. silicestris**

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References

Adams, L.G. (1982a). Appendix. Violaceae. In A.S. George (ed.), *Flora of Australia* 8: 386. Australian Government Publishing Service: Canberra.

Adams, L.G. (1982b). *Viola*. In A.S. George (ed.), *Flora of Australia* 8: 91–100. Australian Government Publishing Service: Canberra.

Baker, M.S. (1935). Studies in western violets. I. *Madroño* 3: 51–57.

Beattie, A.J. (1971). Pollination mechanisms in *Viola*. *New Phytologist* 70: 343–360.

—— (1974). Floral evolution in *Viola*. *Annals of the Missouri Botanical Garden* 61: 781–783.

—— (1976). Plant dispersion, pollination and gene flow in *Viola*. *Oecologia* 25: 291–300.

Beattie, A.J. & Lyons, N. (1975). Seed dispersal in *Viola* (Violaceae): adaptations and strategies. *American Journal of Botany* 62: 714–722.

Chen, Y., Yang, Q., Ohba, H. & Nikitin, V. (2008). Violaceae. In *Flora of China* 13: 72–111. eFloras 2008. Published on the Internet http://www.efloras.org Missouri Botanical Garden: St. Louis, MO & Harvard University Herbaria: Cambridge, MA. Accessed 28 May 2013.

Duretto, M.F. (2009). Violaceae. In M.F. Duretto (ed.), *Flora of Tasmania Online*. Tasmanian Herbarium, Tasmanian Museum & Art Gallery: Hobart. www.tmag.tas.gov.au/floratasmania. Accessed 28 May 2013.

Electronic Flora of South Australia (2007). http://www.flora.sa.gov.au/cgi-bin/speciesfacts_display.cgi?form=speciesfacts&family=&genus=viola&species=&iname=&submit=Display Accessed 28 May 2013.

Elliot, R. & Jones, D. (2010). *Encyclopaedia of Australian plants suitable for cultivation* 9: 441. Lothian: Sydney.

Entwisle, T.J. (1996). Violaceae. In N.G. Walsh & T.J. Entwisle (eds.), *Flora of Victoria* 3: 361–370. Inkata Press: Melbourne.

Freitas, L. & Sazima, M. (2003). Floral biology and pollination mechanisms in two *Viola* species – from nectar to pollen flowers? *Annals of Botany* 91: 311–317.

James, T.A. (1990). Violaceae. In G.J. Harden (ed.), *Flora of New South Wales* 1: 435–441. Royal Botanic Garden: Sydney.

—— (2013). Family Violaceae, In PlantNET - The Plant Information Network System of The Royal Botanic Gardens and Domain Trust, Sydney, Australia (version 2.0). http://plantnet.rbgsyd.nsw.gov.au Accessed 28 May 2013.

Lengyel S., Gove, A.D., Latimer, A.M., Majer, J.D. & Dunn, R.R. (2010). Convergent evolution of seed dispersal by ants, and phylogeny and biogeography in flowering plants: A global survey. *Perspectives in Plant Ecology, Evolution and Systematics* 12: 43–55.

Little, R.J. & Leiper, G. (2012). Capsule dehiscence in *Viola betonicifolia* Sm. (Violaceae). *Austrobaileya* 8: 624–633.

Little, R.J. & McKinney, L.E. In press. Violaceae. In Flora of North America Editorial Committee (eds.), *Flora of North America North of Mexico*, Vol. 6. Flora of North America Association: New York & Oxford.

Stanley, T.D. & Ross, E.M. (1983). *Flora of South-eastern Queensland* 2: 99–101. Queensland Department of Primary Industries: Brisbane.

Thiele, K.R. & Prober, S.M. (2003). New species and a new hybrid in the *Viola hederacea* species complex, with notes on *Viola hederacea* Labill. *Muelleria* 18: 7–26.

—— (2006). *Viola silicestris*, a new species in *Viola* section *Erpetion* from Australia. *Telopea* 11: 99–104.

Pterostylis caligna M.T.Mathieson (Orchidaceae), a new species from northern Queensland

M.T. Mathieson

Summary

Mathieson, M.T. (2013). *Pterostylis caligna* M.T.Mathieson (Orchidaceae), a new species from northern Queensland. ***Austrobaileya* 9(1): 102–106.** *Pterostylis caligna* is described as new. It is a tuberous, terrestrial herb known only from the Hann and Windsor Tablelands in northern Queensland and is readily distinguished from any other members of the genus by its unique combination of characters. The species is illustrated and diagnosed herein. Its conservation status is assessed and a status of Vulnerable is recommended.

Key Words: Orchidaceae, *Pterostylis*, *Pterostylis caligna*, Australia flora, Queensland flora, new species, taxonomy, conservation status.

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Introduction

The greenhood orchids of Australia are diverse and occur in many habitats throughout eastern and southern Australia (Janes & Duretto 2010; Jones & Clements 2002) with a number of new *Pterostylis* species having been described in recent years (Jones 2009a, 2009b, 2010a, 2010b; Jones & French 2012). Nine species are currently known from the Wet Tropics of north Queensland (Jones 2006, 2010a; Bostock & Holland 2010).

During a visit to the Hann Tableland, west of Mareeba in north Queensland in May 2010, the author discovered a population of *Pterostylis* R.Br. that did not match any named species. However, one specimen at BRI corresponded with this species. Further material was collected in March 2012 and April 2013, enabling its distinctiveness to be confirmed and its formal description herein. I follow the classification of Janes & Duretto (2010) under which this species keys to *Pterostylis* subg. *Pterostylis* sect. *Foliosae*.

Materials and methods

This research is based on a study of herbarium specimens and associated spirit collection at BRI and CNS, and field studies at the type and other noted localities. All measurements have been made from live material or material preserved in spirit.

Abbreviations in the specimen citations include NP (National Park). RE refers to Regional Ecosystem, descriptions of which can be viewed at (in this case): http://www.ehp.qld.gov.au/ecosystems/biodiversity/regional-ecosystems/index.php

Taxonomy

Pterostylis caligna M.T.Mathieson **sp. nov.** ab omnibus aliis speciebus *Pterostylis* sepalis lateralibus clavatis, galea decurva apice sepali dorsalis filiformis clavati, labello semper abscondito et apice suo rotundato vel obtuse acuto distat. **Typus:** Queensland. Cook District: Hann Tableland National Park, NW of Mareeba, 8 April 2013, *M.T. Mathieson MTM1438 & P.I.Forster* (holo: BRI [1 sheet + spirit]; iso: CNS, *distribuendi*).

Tuberous, terrestrial herb growing in clonal colonies. Tubers globose to ovoid, 6–9 mm long, 5–9 mm wide when fertile. Leaves 3–5 in a rosette encircling the base of the scape, mid-green; lamina linear-ovate to oblong-ovate, 14–34 mm long, 9–19 mm wide, margins entire or occasionally crisped, apex obtuse to bluntly acute; petioles 3–13 mm long, slender, not winged. Scape 42–100 mm

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tall, 0.9–1.2 mm wide, glabrous; stem bracts, sterile 1 (rarely 2), fertile 1, 8–15 mm long, 2.5–5 mm wide, lanceolate, acute, sheathing at base, margins entire. Flower solitary 17–23 mm long, erect, translucent white with pale to bright green stripes on the galea and sinus. Galea slightly gibbous at the base, then erect before curving forwards in a semicircular fashion with the tip decurved. Dorsal sepal translucent white with bright green stripes, three narrow inner stripes and two broad marginal stripes which coalesce in the distal quarter, 15–20 mm long, 6–9 mm wide, inflated at the base and tapered beyond to the apex with a slight constriction in the proximal third, apex filiform, clubbed, 2.5–3 mm long. Lateral sepals erect closely embracing the galea; sinus protruding slightly to moderately, shallowly curving inwards, the upper margin shallowly notched at the centre then curving upwards; conjoined part 7–10 mm long, 6–8 mm wide, narrowed to *c.* 2.5 mm at the base, bright green fading somewhat towards the base, the upper margins inrolled, gradually tapered into the free points; free points filiform, minutely clubbed, 8–13 mm long, erect, held upright above the galea. Petals asymmetrically lanceolate, falcate, 13–16 mm long, 3.5–4.5 mm wide, tapered in the distal half, apex acute to subattenuate, largely bright green with a small area of the central proximal section translucent pale green to white; flange 1–1.2 mm wide, broadly deltate, obtuse. Labellum attached to a short basal claw *c.* 1 mm long, erect, slightly curved in the distal quarter, not visible through the sinus in the set position, green in the proximal half and suffused tan-brown distally; lamina narrowly oblong to narrowly oblong-lanceolate, 5–7 mm long, 1.5–2 mm wide, slightly constricted in the distal half; apex bluntly acute to rounded; central callus slightly raised, running the length of the labellum ending just short of apex, *c.* 0.25 mm wide tapered to *c.* 0.1 mm in the centre, green in proximal half, tan-brown distally; basal appendage linear 2–3 mm long, curved, apex irregularly lobed. Column green, brown and white, 6–7 mm long, erect, angled away from ovary at about 40° in the proximal quarter, then erect. Column wings 3–4 mm long; basal lobe 1.5–2 mm long, *c.* 1.2 mm wide, green and brown, at an angle of 50°, apex obtuse, inner margins incurved, sparsely adorned with short, translucent white cilia; mid section 0.8–1 mm long, brown and white; apical lobe, white, linear, 0.6–0.7 mm long, obtuse. Stigma elliptic, 1.5–1.8 mm long, *c.* 0.75 mm wide, raised, situated centrally on the column. Anther *c.* 0.7 mm, shortly rostrate. Pollinia linear-clavate, 0.6–0.7 mm long, yellow, mealy. Ovary cylindrical to slenderly obovoid, 6–11 mm long, 1.5–2 mm wide, green, irregularly ribbed. Capsule narrowly obovoid, 13–18 mm long, 4–5 mm wide, ribbed, smooth. **Fig. 1–3.**

***Additional specimens examined*: Queensland.** Cook District: Hann Tableland NP, NW of Mareeba, May 2010, *Mathieson MTM828 & Forster* (BRI); Windsor Tableland NP, N of Mt Carbine, Apr 2013, *Mathieson MTM1523, 1555 & Forster* (BRI); Windsor Tableland, Jan 2009, *Sankowsky 3084 & Sankowsky* (BRI).

***Distribution and habitat*:** *Pterostylis caligna* is endemic to northern Queensland and has been found only in the Hann Tableland NP, about 20 km north-west of Mareeba and Mt Windsor NP approximately 90 km north-north-west of Mareeba. It grows in simple notophyll vine forest with emergent *Agathis robusta* (C.Moore ex F.Muell.) F.M.Bailey on granite (RE 7.12.16a) on the Hann Tableland and in simple to complex notophyll vine forest with emergent *Agathis robusta* (RE 7.12.7a) on the Windsor Tableland between 880 m and 1000 m. At both localities, this species appears to be associated with vine forest–open forest ecotones.

***Phenology*:** Flowers and fruits are recorded for January through to April; also in May, when very few flowering plants were observed and most fruit had dehisced.

***Affinities*:** *Pterostylis caligna* stands apart from all other members of the genus by the following characters: clubbed lateral sepals, decurved galea with apex of dorsal sepal filiform and clubbed, labellum always concealed when in the set position and labellum apex rounded or bluntly acute. Sterile rosettes can resemble those of *Pterostylis taurus* M.A.Clem. & D.L.Jones.

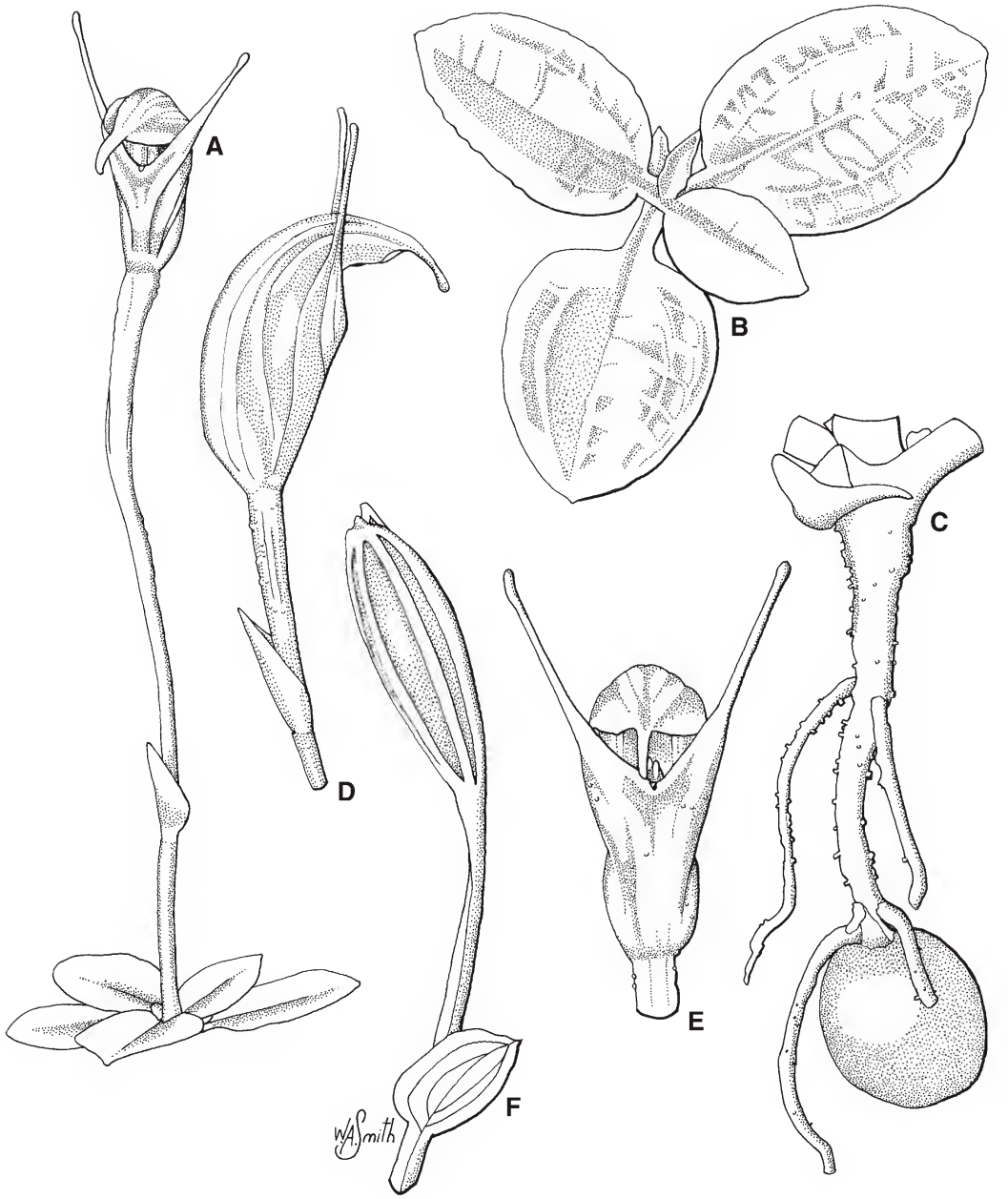

Fig. 1. ***Pterostylis caligna***. A. whole plant ×2. B. rosette ×2. C. root stock and tuber ×4. D. flower from the side ×3. E. flower from the front ×3. F. undehisced capsule ×3. All from *Mathieson MTM1438 & Forster* (BRI). Del. W.Smith.

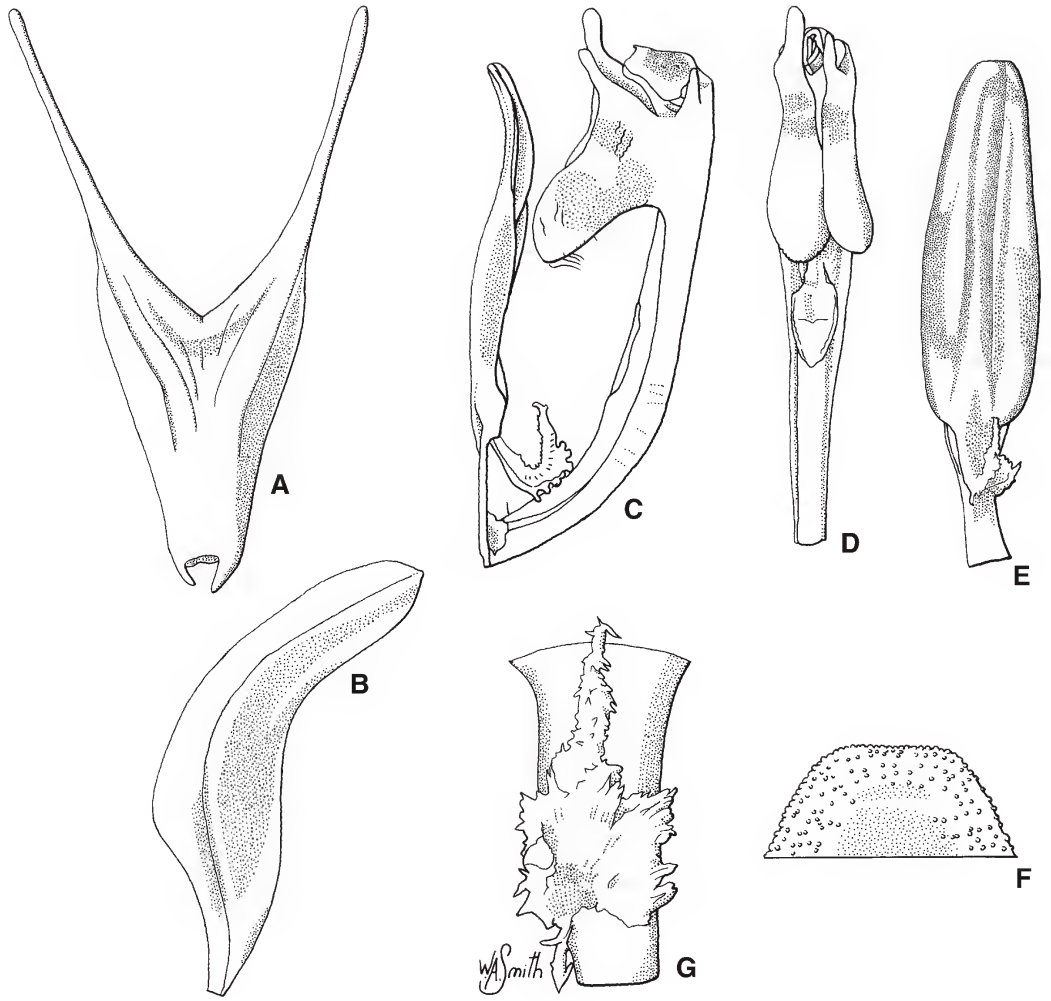

Fig. 2. ***Pterostylis caligna.*** A. lateral sepals (synsepalum) ×4. B. petal ×4. C. column and labellum from the side ×8. D. column from the front ×12. E. labellum from above ×12. F. labellum apex ×32. G. basal appendage of labellum from above ×32. All from *Mathieson MTM1438 & Forster* (BRI). Del. W.Smith.

***Conservation status*:** This species is known from three locations; one within the Hann Tableland NP and two in the Windsor Tableland NP. It was not encountered elsewhere on the Hann Tableland despite extensive searches in similar habitats during three expeditions between 2010 and 2013. It is likely to occur elsewhere on the Windsor Tableland and adjacent ranges in the Wet Tropics biogeographic region given the extent of appropriate habitat that exists.

The population at the type locality is estimated to be between 100 and 200 plants occupying an area of less than one hectare. The two populations on the Windsor Tableland were estimated at between 300 and 400 plants, both occupying an area of less than two hectares. Repeated fire events may threaten this species by encouraging the encroachment of introduced, hyperinvasive grasses (*viz.* giant rat's tail grass *Sporobolus pyramidalis* (Lam.) Hitchc., grader grass *Themeda quadrivalvis* (L.) Kuntze and

gamba grass *Andropogon gayanus* Kunth), the rampant herbaceous weed *Praxelis clematidea* R.M.King & H.Rob. and lantana *Lantana camara* L. into its' ecotone habitats. Applying criteria of the IUCN (IUCN 2001), the recommended conservation status is Vulnerable (D1, D2).

***Etymology*:** From the Greek *calignis* – of the mists, in reference to the upland cloud forest this species inhabits.

Fig. 3. *Pterostylis caligna*, side view of the flower, photographed in habitat (*Mathieson MTM828*).

Acknowledgements

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References

Bostock, P.D. & Holland, A.E. (eds) (2010). *Census of the Queensland Flora 2010*. Queensland Herbarium, Department of Environment and Resource Management: Brisbane.

Iucn (2001). *IUCN Red List of Categories and Criteria: Version 3.1*. IUCN Species Survival Commission: Gland (Switzerland)/Cambridge (United Kingdom).

Janes, J. & Duretto, M. (2010). A new classification for subtribe Pterostylidinae (Orchidaceae), reaffirming *Pterostylis* in the broad sense. *Australian Systematic Botany* 23: 260–269.

Jones, D.L. (2006). *A complete guide to native orchids of Australia, including the island territories*. New Holland: Sydney.

—— (2009a). Five threatened new species of *Hymenochilus* (Orchidaceae) from southern Australia. *The Orchadian* 16: 176–187.

—— (2009b). *Oligochaetochilus pedinus*, a new species of Orchidaceae from south-western New South Wales. *The Orchadian* 16: 214–221.

—— (2010a). Four new species of *Oligochaetochilus* (Orchidaceae) from tropical Queensland. *The Orchadian* 16: 302–311.

—— (2010b). A new species of *Oligochaetochilus* (Orchidaceae) from Queensland with affinities to *O. woollsii*. *The Orchadian* 16: 370–375.

Jones, D.L. & Clements, M.A. (2002). A review of *Pterostylis* (Orchidaceae). *Australian Orchid Research* 4: 1–168.

Jones, D.L. & French, C.J. (2012). Two new species of *Pterostylis* from Western Australia. *Australian Orchid Review* 77(4): 39–44.

Two new subspecies of *Eucalyptus tereticornis* Sm. (Myrtaceae)

A.R. Bean

Summary

Bean, A.R. (2013). Two new subspecies of *Eucalyptus tereticornis* Sm. (Myrtaceae). ***Austrobaileya* 9(1): 107–113**. Two new subspecies of *Eucalyptus tereticornis* Sm., *E. tereticornis* subsp. *rotunda* A.R.Bean and *E. tereticornis* subsp. *basaltica* A.R.Bean, are described and illustrated. A key to the four subspecies of *E. tereticornis* is provided, together with a distribution map for the new taxa.

Key Words: Myrtaceae, *Eucalyptus*, *Eucalyptus tereticornis* subsp. *basaltica*, *Eucalyptus tereticornis* subsp. *rotunda*, new subspecies, Australia flora, Queensland flora, identification key, taxonomy

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Introduction

Eucalyptus tereticornis Sm. is one of the best known members of the largely eastern Australian 'Red Gum' group (*E.* sect. *Exsertaria* L.D.Pryor & L.A.S.Johnson ex Brooker), characterised by the reniform cotyledons, concolorous adult leaves, ovules in 6–8 longitudinal rows, and the toothed seed coat. Brooker (2000) placed *E. tereticornis* in *E.* ser. *Erythroxylon* (Blakely) Brooker, along with 14 other species, distinguished by the patchily deciduous bark, leaves with moderately dense reticulation, erect stamens, pyramidal or obliquely pyramidal seeds and axillary inflorescences.

Eucalyptus tereticornis is a widespread and variable species; it extends from eastern Victoria to north Queensland, and to Papua New Guinea. Brooker & Slee (2000) documented a number of variants of *E. tereticornis*: *E. tereticornis* subsp. *tereticornis* (long operculum swollen at the base), the 'Hunter Valley' form (with short obese opercula, ± parallel-sided), the 'Tenterfield–Cunningham's Gap' form (operculum shorter than typical form and lacking the swollen base), *E. tereticornis* subsp. *mediana* Brooker & Slee (from eastern Victoria), and *E. blakelyi* – *E. tereticornis* intergrades.

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Eucalyptus tereticornis subsp. *tereticornis* is the most widespread subspecies, extending from the south coast of New South Wales to north of Cooktown in Queensland, and Central and Oro (Northern) Districts in Papua New Guinea. In southern Queensland, it extends west to near Roma (Queensland Herbarium 2013).

Eucalyptus tereticornis subsp. *basaltica* A.R.Bean, described here, is a widespread tree on hills and ridges (predominantly basaltic) of southern Queensland and northern New South Wales. The 'Hunter Valley' form and 'Tenterfield–Cunningham's Gap' form of Brooker & Slee (2000) are both attributable to this subspecies.

An additional taxon, described here as *Eucalyptus tereticornis* subsp. *rotunda* A.R.Bean, is a riparian tree of restricted distribution from the upper reaches of the Maranoa River of southern Queensland with large orbicular juvenile leaves.

Eucalyptus tereticornis subsp. *mediana* Brooker & Slee differs from *E. tereticornis* subsp. *tereticornis* by the glaucous juvenile leaves, shorter obese operculum, mixed black single-coated and yellow double-coated seeds, and the later flowering period (Brooker & Kleinig 1999). It inhabits stream banks and river floodplains, but also low hills and plains not subject to flooding (Nicolle 2006).

Eucalyptus tereticornis subsp. *mediana* and *E. tereticornis* subsp. *rotunda* are geographically isolated from the other subspecies, although the latter occurs in close proximity to an outlying stand of *E. tereticornis* subsp. *basaltica*. *E. tereticornis* subsp. *tereticornis* and *E. tereticornis* subsp. *basaltica* are parapatric in southern Queensland and northern New South Wales, and some hybridisation or intergradation is suspected between the two taxa.

Subspecies rank is considered appropriate for the new taxa, as there are consistent characters to separate them from *E. tereticornis* subsp. *tereticornis*.

Materials and methods

This study is based on a combination of field studies in Queensland and northern New South Wales, measurements made during an earlier seedling trial that included *Eucalyptus tereticornis* subsp. *tereticornis* and *E. tereticornis* subsp. *basaltica*, and an examination of specimens at BRI. *E. tereticornis* subsp. *mediana* has not been observed in the field, and knowledge of the taxon has been gleaned from the literature and from herbarium specimens. Measurements have been made from dried herbarium material.

Common abbreviations used in the text include Mt (Mountain), S.F. (State Forest).

Taxonomy

Eucalyptus tereticornis Sm., *Spec. Bot. New Holland*, part 4, 41 (1795). **Type:** New South Wales. Port Jackson, 1793, *J. White s.n.* (holo: LINN; iso: BM, *fide* Chippendale [1988: 324]).

Tree to 50 m high. Bark smooth throughout or with persistent grey, scaly-fibrous bark at base, forming a stocking less than one-tenth tree height; smooth bark deciduous, somewhat shiny, dappled white, grey, brown or pale blue, shedding in irregular strips less than a metre long. Adult branchlets not glaucous. Seedling leaves broadly ovate to orbicular, stems quadrangular. Juvenile leaves petiolate, alternate, broadly-lanceolate to orbicular, concolorous or slightly discolorous. Adult leaves alternate, narrow-lanceolate to lanceolate or falcate, 8–21 × 1–3.5 cm, concolorous, green, petiolate, lateral veins at 35–55° to the midrib, vein reticulation moderately dense, oil glands abundant, several per areole; intramarginal vein less than 20% of distance from margin to midrib, margins entire, base cuneate. Inflorescence with umbels borne singly in leaf axils or along leafless stems. Individual umbels 7(–9)-flowered; peduncle terete or

Key to subspecies of *Eucalyptus tereticornis*

1 Opercula of mature buds expanded at base; juvenile leaves broadly lanceolate to ovate, 2–3.2 times longer than wide . . . **E. tereticornis** subsp. **tereticornis**
1. Opercula of mature buds not expanded at base; juvenile leaves orbicular to ovate, 0.85–2 times longer than wide **2**

2 Juvenile leaves orbicular, 0.85–1.2 times longer than wide, 5–16 cm across, green, apex obtuse, apiculate or emarginate . . . . **E. tereticornis** subsp. **rotunda**
2. Juvenile leaves broadly ovate to ovate, 1.2–2.0 times longer than wide, dull bluish, apex acute **3**

3 Pedicels 1–3 mm long; opercula 1.3–1.6 times longer than broad; new growth of juvenile plants pruinose; margins of juvenile leaves usually undulate; seeds coats a mixture of black and yellow . . . **E. tereticornis** subsp. **mediana**
3. Pedicels 2.5–6 mm long; opercula 1.5–2 times longer than broad; new growth of juvenile plants dull green; margins of juvenile leaves not undulate; seed coats all black . . . . . **E. tereticornis** subsp. **basaltica**

angular, 7–20 mm long. Buds with operculum scar present, stamens erect to slightly sinuate, staminodes absent, filaments white or rarely pink; opercula longer than hypanthium. Stigma blunt or slightly dilated. Ovules in six or more longitudinal rows. Fruits cupular, oblate or hemispherical, 4–7(–8) mm long, 5–8(–10) mm wide, pedicellate. Disc convex, obliquely ascending; valves 3–5, strongly exserted. Seeds pyramidal or cuboid, larger and darker than chaff, 0.8–1.5 mm long, usually black with toothed edges, but sometimes yellow and with smooth edges; hilum terminal.

Eucalyptus tereticornis subsp. **basaltica** A.R.Bean **subsp. nov.** a subspecie typica operculis quae sunt e basi non expansa, foliis juvenilibus late ovatis (late lanceolatis usque ovatis in subspecie typica) et habitatione clivorum et summorum jugorum differens. **Typus:** Queensland. DARLING DOWNS DISTRICT: Near Bottle Tree Lookout, Bunya Mountains National Park, 21 May 1996, *P. Grimshaw PG2468 & L.M. Grimshaw* (holo: BRI [3 sheets]; iso: NSW).

Eucalyptus tereticornis 'Hunter Valley form' (Brooker & Slee 2000)

Eucalyptus tereticornis 'Tenterfield-Cunningham's Gap form' (Brooker & Slee 2000)

Eucalyptus tereticornis subsp. (Bunya Mountains P.V. Holzworth AQ397993), Bostock & Holland (2010: 121).

Eucalyptus tereticornis subsp. (Consuelo Tableland M.I. Brooker B4880), Bostock & Holland (2010: 121).

Tree to 20 m high. Base of trunk sometimes with slabs of persistent grey, scaly-fibrous bark, extending up to 1 metre; bark smooth above, deciduous, somewhat shiny and dappled with white, creamy-white, yellow and brown. Juvenile leaves ovate to almost orbicular, bluish green, 6.5–12.5 × 4–7 cm, 1.2–2 times longer than broad, concolorous; apex acute, base cuneate; margins entire or crenulate, petioles 11–22 mm long. Adult leaves lanceolate to falcate, 90–160 × 12–32 mm, green; apex attenuate; petioles 11–21 mm long. Inflorescences 7-flowered or rarely 9-flowered; peduncles ± terete or obviously flattened, 7–13 mm long; pedicels 2.5–6 mm long; mature buds ovoid to ellipsoid, 9–14 × 5–6 mm; outer operculum shed early, inner operculum cylindrical-oblong to conical, 7.5–11 × 5–6 mm, 1.5–2 times longer than broad, not expanded at base, apex obtuse or acute; stamens white; outer stamens erect in bud, up to 9.5 mm long. Fruits cupular to oblate, 5–7 mm long (excluding valves), 6–8 mm wide, valves 3–5, pedicels 2–7 mm long. **Fig. 1A-E**.

***Additional selected specimens examined*: Queensland.** PORT CURTIS DISTRICT: Kroombit Tableland, *c.* 60 km SW of Gladstone, Amy's Peak, Jun 1977, *Crisp 2824* (BRI). BURNETT DISTRICT: Foothills of Bunya Mountains S.F., Jul 1985, *Holzworth s.n.* (BRI [AQ397993]); Mt Mowbullan, Bunya Mountains, Jul 1994, *Fensham 1781* (BRI); Bunya Mountains, Mt Kiangarow, Dec 1954, *Smith 6261* (BRI). WIDE BAY DISTRICT: Woowoonga S.F. 287, 2 km from Mt Goonaneman, *c.* 12 km NE of Biggenden, Apr 1989, *Last s.n.* (BRI [AQ455525]); Widgee Mt, Apr 1996, *Forster PIF19137 & Leiper* (AD, BRI, CANB, MEL, NSW). MARANOA DISTRICT: 3 km W of the 'Stock Yard' on the Consuelo Tableland, Dec 1980, *Gunn BG227* (BRI); Consuelo Tableland, May 1982, *Neldner & Thomas 683* (BRI). DARLING DOWNS DISTRICT: *c.* 6.6 miles [10.6 km] N of Yamsion on Bunya Mountains road, May 1961, *Smith 11365* (BRI); western slope of Cunningham's Gap, Jun 1957, *Blake 20134* (BRI); *c.* 4 km along Spicer's Gap road from the west, at S.F. gate, Oct 1995, *Brooker 12417 & Slee* (BRI, CANB, MEL, NSW); Spicer's Gap, Jun 1963, *Everist 7285* (BRI); Allora Council Reserve, Sep 2002, *Menkins ILM0122* (BRI). MORETON DISTRICT: Main Range, between Spring Bluff & Murphy's Creek, Aug 1930, *Hubbard 3530* (BRI); near Kooralbyn Resort, Sep 1998, *Larson s.n.* (BRI [AQ662937]); Mt Cotton ridge, Oct 2008, *Bean 28106* (BRI); WNW ridge of Lost World, Jan 1989, *Weston 1368 & Richards* (BRI, NSW); Mt Cainbabel, Macpherson Range, May 1930, *White 6766* (BRI). **New South Wales.** Upper Acacia Creek, Jun 1951, *Everist 2550 & Webb* (BRI); 3.8 km along Middle Creek Road from Cressfield Road, *c.* 2 km up ridge to west, Sep 1985, *Hill 1319* (BRI, NSW); 8.6 km SW of Scone towards Merriwa, Oct 1995, *Brooker 12350 & Slee* (BRI, CANB); 8.3 km N of Wiseman's Ferry, W edge of MacDonald River, Oct 1995, *Brooker 12340 & Slee* (BRI, CANB).

***Distribution and habitat*:** *Eucalyptus tereticornis* subsp. *basaltica* extends from north-west of Sydney to Kroombit Tops, south-west of Gladstone, and there is an outlier on the Carnarvon Range north of Mitchell (**Map 1**). It is a component of eucalypt woodland, commonly associated with *Eucalyptus eugenioides* Sieber ex Spreng., *E. melliodora* A.Cunn. ex Schauer, and *E. biturbinata*

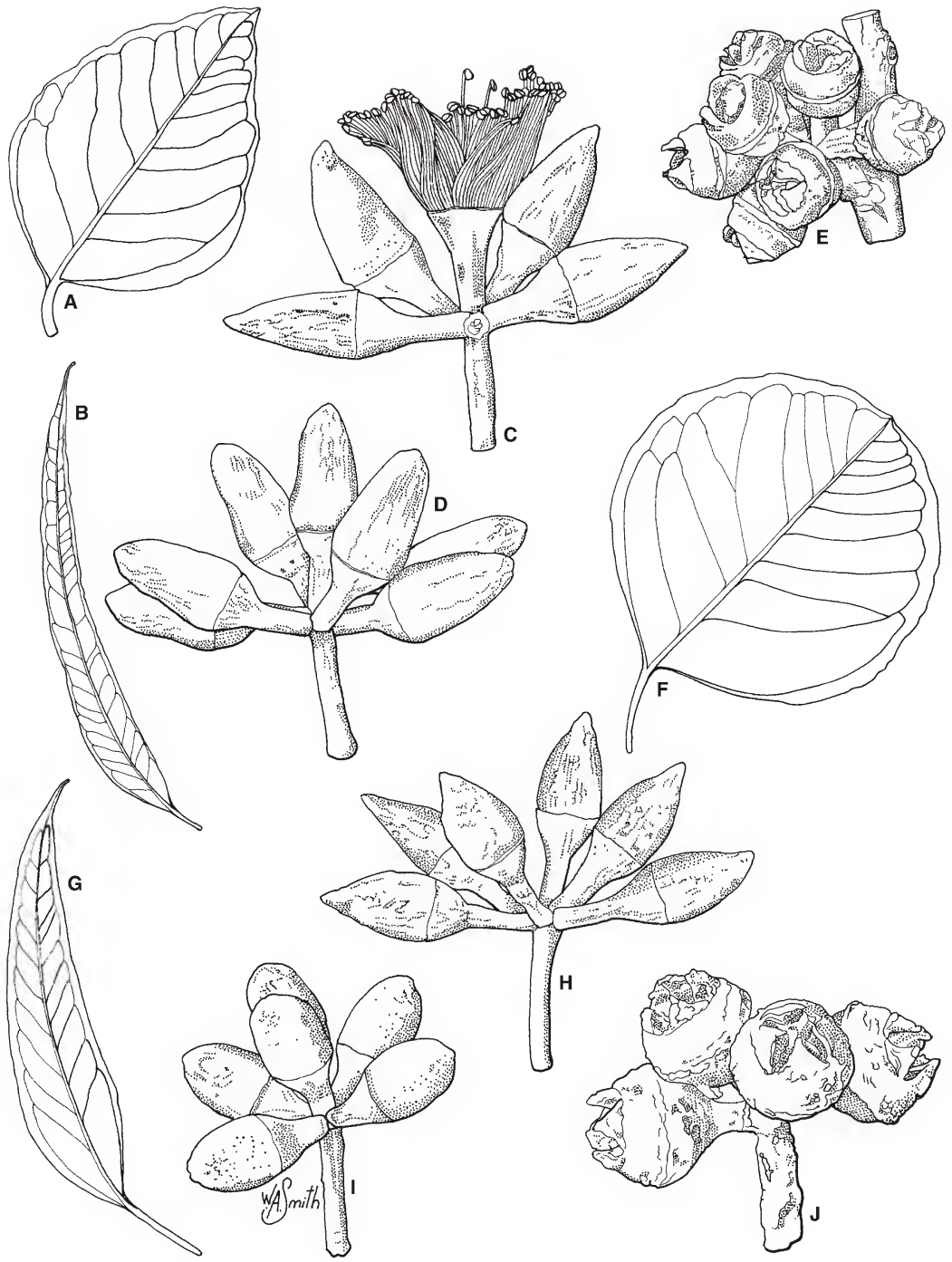


Fig. 1. ***Eucalyptus tereticornis*** subsp. ***basaltica*** A. juvenile leaf ×0.5. B. adult leaf ×0.6. C. cluster of mature buds ×2. D. cluster of mature buds ×2. E. cluster of mature fruits ×2. ***E. tereticornis*** subsp. ***rotunda*** F. juvenile leaf ×0.5. G. adult leaf ×0.6. H. cluster of mature buds ×2. I. cluster of mature buds ×2. J. cluster of mature fruits ×3. A,B,E from *Grimshaw 2468 & Grimshaw* (BRI); C from *Bean 28106* (BRI); D from *Larson s.n.* (BRI [AQ662937]); F,G,I from *Bean 31323* (BRI); H from *Bean 31321* (BRI); J from *Bean 25804* (BRI). Del. W.Smith.

L.A.S.Johnson & K.D.Hill. It most commonly grows on basalt substrates, in brown to black clayey soil, but may sometimes grow on soils derived from rhyolite or granite, and rarely, serpentinite. Altitudes vary from 100 metres to 1150 metres.

***Phenology*:** Flowers have been collected from May to December; fruits may be found all year round.

***Notes*:** *Eucalyptus tereticornis* subsp. *basaltica* differs from *E. tereticornis* subsp. *tereticornis* by the opercula that are not expanded at the base, the broadly ovate juvenile leaves (broadly lanceolate to ovate for *E. tereticornis* subsp. *tereticornis*), and the hillside or ridge top habitat. The buds and leaves of *E. tereticornis* subsp. *basaltica* are often smaller than those of the typical subspecies, but there is some overlap.

This subspecies was recognised as a distinct taxon by Clifford (1972), who referred to differences in the size of the buds and fruits, and the shape of the juvenile leaves.

***Conservation status*:** A widespread and common subspecies.

***Etymology*:** The epithet refers to the basaltic substrate upon which this subspecies usually grows.

Eucalyptus tereticornis subsp. **rotunda** A.R.Bean **subsp. nov.** a subspecie typica foliis juvenilibus orbicularibus apice obtuso emarginatove praeditis (lanceolato usque ovato apice acuto in subspecie typica) et operculis brevioribus quae sunt e basi non expansa differens. **Typus:** Queensland. MARANOA DISTRICT: Western Creek, 'Mt Owen', *c.* 140 km N of Mitchell, 28 November 2006, *A.R. Bean 25804* (holo: BRI; iso: CANB, MEL, NSW, *distribuendi*).

A tree to 28 m high. Base of trunk with slabs of persistent grey, scaly-fibrous bark, extending up to 2 metres; bark smooth above, deciduous, somewhat shiny and dappled with white, creamy-white and brown. Juvenile leaves orbicular, 60–180 × 60–160 mm, 0.85–1.2 times longer than broad, concolorous or slightly discolorous, bright green; apex obtuse or emarginate, rarely apiculate, base cuneate or obtuse; margins entire or crenulate, petioles 12–32 mm long. Adult leaves lanceolate to falcate, 90–190 × 18–32 mm, concolorous, green; apex attenuate; petioles 18–30 mm long. Inflorescences 7-flowered; peduncles ± terete, 7–14 mm long; pedicels 2–3.5 mm long; mature buds ovoid to ellipsoid, 7.5–10 × 4.5–5.5 mm; outer operculum shed early, inner operculum cylindrical-oblong to conical, 6–7 × 4.5–5.5 mm, 1.3–1.7 times longer than broad, apex obtuse, acute or umbonate; stamens white; outer stamens erect in bud, though slightly sinuate, up to 5.5 mm long. Fruits cupular to oblate, 4–5 mm long (excluding valves), 5.5–7 mm wide, valves 4 or 5, pedicels 1.5–3.5 mm long. **Fig. 1F-J**.

***Additional specimens examined*:** **Queensland**. MARANOA DISTRICT: Western Creek, *c.* 12 km N of 'Mt Owen' Homestead, N of Mitchell, Nov 2011, *Bean 31321 & Halford* (BRI, CANB, MEL, NSW); *ditto loc.*, Nov 2011, *Bean 31323 & Halford* (BRI, NSW); 16.2 km from Consuelo Tableland towards Mt Moffatt, Dec 1982, *Brooker 7891* (BRI, CANB).

***Distribution and habitat*:** *Eucalyptus tereticornis* subsp. *rotunda* is endemic to Queensland. It is known from a limited area north of Mitchell, on 'Mt Owen' Station, and in the Mt Moffatt section of Carnarvon National Park (**Map 1**). It grows along creek banks, at altitudes between 550 and 700 metres.

***Phenology*:** Flowers have been recorded in November; fruits in November and December.

***Affinities*:** *Eucalyptus tereticornis* subsp. *rotunda* differs from *E. tereticornis* subsp. *tereticornis* by the orbicular juvenile leaves with obtuse or emarginate apex (broadly lanceolate to ovate juveniles with acute apex for *E. tereticornis* subsp. *tereticornis*); the opercula of mature buds not expanded at base, 7.5–10 mm long with obtuse apex (opercula of mature buds expanded at base, 11–17 mm long, with acute apex for *E. tereticornis* subsp. *tereticornis*).

Eucalyptus tereticornis subsp. *rotunda* differs from *E. tereticornis* subsp. *basaltica* by the orbicular juvenile leaves with obtuse or emarginate apex (broadly ovate juveniles with acute apex for *E. tereticornis* subsp. *basaltica*), and the riverine habitat.

The juvenile leaves of *Eucalyptus tereticornis* subsp. *rotunda* are similar in size, shape and colour to those of *E. amplifolia* subsp. *amplifolia*, but *E. tereticornis* subsp. *rotunda* differs by the mature buds 7.5–10 mm long (10–12 mm for *E. amplifolia* subsp. *amplifolia*); the inflorescences 7–flowered (9–11-flowered for *E. amplifolia* subsp. *amplifolia*); the obtuse opercula (acute for *E. amplifolia* subsp. *amplifolia*) and the narrower adult leaves.

***Notes*:** *Eucalyptus tereticornis* subsp. *rotunda* is found on the upper tributaries of the Maranoa River. The type specimen of *E. camaldulensis* subsp. *acuta* Brooker & M.W.McDonald was collected at 'Forest Vale', a property between Mitchell and 'Mt Owen', also on the Maranoa River. However, *E. tereticornis* subsp. *rotunda* and *Eucalyptus. camaldulensis* subsp. *acuta* are thought to be allopatric, with occurrences of the latter starting 30–40 km downstream from occurrences of the former. *E. camaldulensis* subsp. *acuta* can be distinguished by its bluish, lanceolate juvenile leaves, the fruiting valves set at a considerable angle to the disc, and the seeds with a yellow coat.

Eucalyptus tereticornis subsp. *rotunda* is conspecific with the type of *E. populifolia* Hook., which is the basionym for *E. populnea* F.Muell., a name currently applied to the Poplar box. The typification of *E. populnea* is the subject of a current conservation proposal (Bean 2012).

***Conservation status*:** A conservation status of **Near Threatened** is proposed under Criterion D, i.e. area of occupancy less than 40 square kilometres, and fewer than 10 localities known (IUCN 2001). A minimum of 2000 trees have been observed at Mt Owen. The population size at Mt Moffatt is not known.

***Etymology*:** The subspecific epithet is from the Latin *rotundus*, meaning round. This refers to the shape of the juvenile leaves.

Acknowledgements

I am grateful to Will Smith for the illustrations and distribution map, Peter Bostock for the Latin diagnoses, and an anonymous referee for helpful comments and suggestions.

References

Bean, A.R. (2012). Proposal to conserve the name *Eucalyptus populnea* (Myrtaceae) with a conserved type. *Taxon* 61: 1332–1333.

Bostock, P.D. & Holland, A.E. (eds) (2010). Census of the Queensland Flora 2010. Queensland Herbarium, Department of Environment and Resource Management: Brisbane.

Brooker, M.I.H. (2000). A new classification of the genus *Eucalyptus* L'Her. (Myrtaceae). *Australian Systematic Botany* 13: 79–148.

Brooker, M.I.H. & Kleinig, D.A. (1999). *Field Guide to Eucalypts*, Volume 1 - *South-eastern Australia*, 2nd edition. Bloomings Books: Hawthorn, Victoria.

Brooker, M.I.H. & Slee, A.V. (2000). Studies in the Red Gums of south-eastern Australia with particular emphasis on *Eucalyptus* subser. *Erythroxyla*. *Australian Forestry* 63: 86–106.

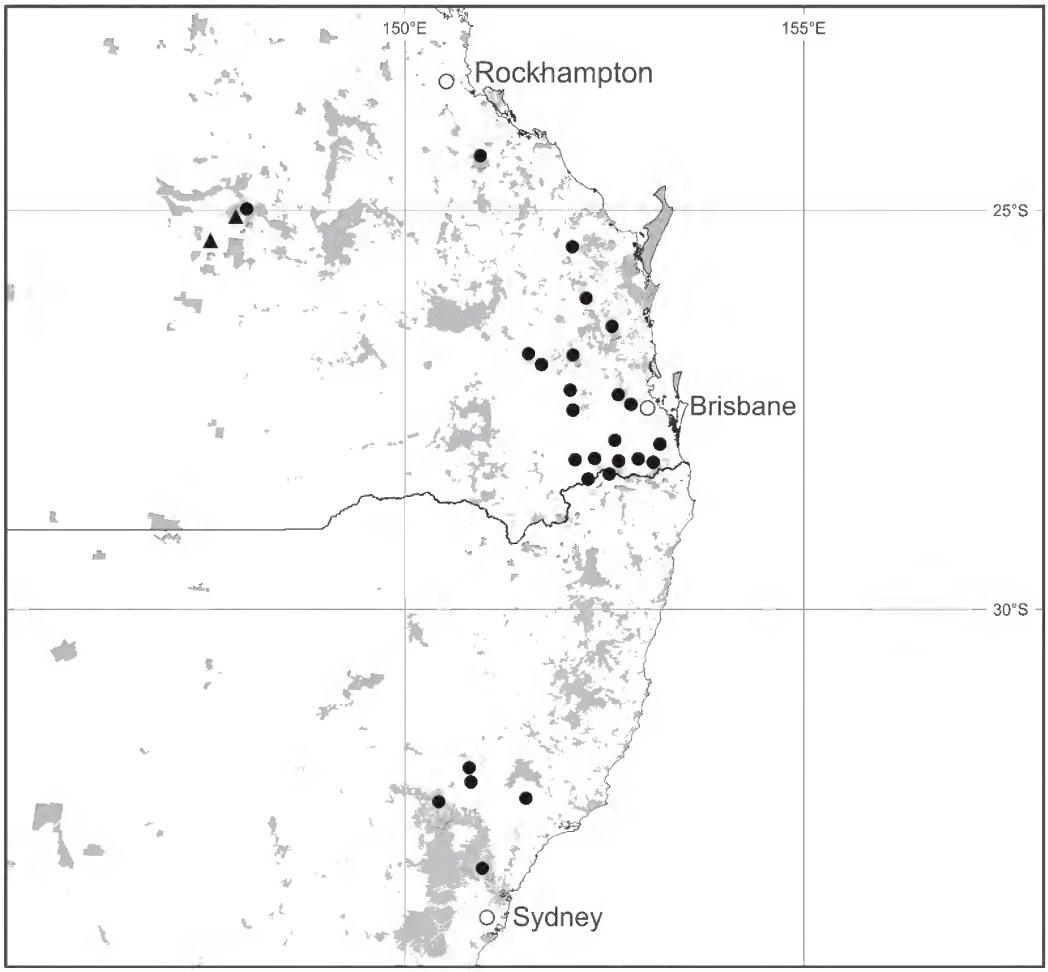
Chippendale, G.M. (1988). *Eucalyptus, Angophora* (Myrtaceae). *Flora of Australia* Volume 19. Australian Government Publishing Service: Canberra.

Clifford, H.T. (1972). *Eucalypts of the Brisbane Region*. Queensland Museum: Brisbane.

Iucn (2001). *IUCN Red List Categories: version 3.1*. IUCN Species Survival Commission. IUCN: Gland, Switzerland.

Nicolle, D. (2006). *Eucalypts of Victoria and Tasmania*. Bloomings Books: Melbourne.

Queensland Herbarium (2013). Specimen label information (HERBRECS), viewed 22 Feb 2013.



Map 1. Distribution of *Eucalyptus tereticornis* subsp. *basaltica* ● and *E. tereticornis* subsp. *rotunda* ▲.

A new fern species for Queensland: *Diplazium squamuligerum* (Rosenst.) Parris (Woodsiaceae)

Daniel J. Ohlsen[1] & Ashley R. Field[2]

Summary

D.J.Ohlsen & A.R.Field (2013). A new fern species for Queensland: *Diplazium squamuligerum* (Rosenst.) Parris (Woodsiaceae). ***Austrobaileya* 9(1): 114–125.** The taxonomic status of an unknown fern species from the Atherton Tableland, north-east Queensland, hitherto attributed to *Asplenium* L., was investigated. Phylogenetic analysis of *trn*L-F and *rbc*L chloroplast DNA sequences supported classification in *Diplazium* Sw., a finding supported by closer examination of scale features. Inspection of *Diplazium* type material determined that the Australian material belongs to *Diplazium squamuligerum* (Rosenst.) Parris, a species previously described from Papua New Guinea. A thorough description of this species and an amended key to the *Diplazium* species of Australia are provided. This study highlights the value of molecular study and close inspection of scale features for fern identification. Taxonomic revision in *Diplazium* is also discussed in light of the findings presented.

Key Words: fern, Athyriaceae, Woodsiaceae, *Diplazium*, *Diplazium squamuligerum*, Australia flora, Queensland flora, Wet Tropics bioregion, new species record, taxonomy

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Introduction

The Wet Tropics of north-east Queensland, from Ingham north to Cooktown, contains the highest fern species diversity in Australia. 257 leptosporangiate fern species occur in the region, which is 66% of the total for Australia (McCarthy 1998). While 37 of these are considered to be endemic to this region, the vast majority are widespread being shared with neighbouring tropical islands, particularly New Guinea which shares 56% of tropical Australian leptosporangiate fern species (McCarthy 1998). Several such species are extremely rare in Australia, known only from one or a few small populations. Notable examples are *Asplenium pellucidum* Lam. and *Hymenasplenium unilaterale* (Lam.) Hayata, both restricted to a single known population in Australia (Brownsey 1998).

The rarity of some taxa has delayed their discovery until relatively recently in Australia. *Lecanopteris sinuosa* (Wall. ex Hook.) Copel., known from only three sites in Australia, was described (as *Polypodium sinuosa* Wall. ex Hook.) from Indonesia in 1863, but was not collected in Australia until 1985 when it was found on Moa Island, Torres Strait. It was later collected on Cape York in 1987, and was formally recognised as an Australian species (Andrews 1990). Entirely new taxa, endemic to north-east Queensland have also gone unnoticed until relatively recently. These include *Antrophyum jagoanum* D.L.Jones & Bostock, *Diplazium bostockii* D.L.Jones, and *Lastreopsis windsorense* D.L.Jones (McCarthy 1998). However, the most recent new fern species confirmed for Australia is *Oleandra musifolium* Blume. In contrast to the previous cases, populations of this species have been known in Australia for over 60 years, but under the misapplied name of *O. neriiformis* Cav. (Hovenkamp & Ho 2012).

Four fern specimens collected from two areas on the Atherton tableland, in north-east Queensland, hitherto identified as *Asplenium* sp. indet. (*A.* sp. 'P.E.I. Road' in BRI)

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(Aspleniaceae) on herbarium specimens, also appear to represent a new taxon for Australia (**Fig. 1**). This taxon is clearly morphologically distinct from the 30 Australian *Asplenium* species treated by Brownsey (1998). It was first collected in 1983: once from the North Johnstone Logging Area (*Lockyer s.n.*), which is thought to be from a population on the west side of Topaz National Park (N.P.) (B.Gray pers. comm.), and twice from Maalan, 20 km further south. The fourth and most recent collection, in 2005 (*Sankowsky & Sankowsky 2637*), was from near the end of P.E.I. Road in Topaz N.P., within one km of the suspected location of the Lockyer collection.

Determining the taxonomic status of taxa in Aspleniaceae is often fraught with difficulty. Aspleniaceae is the largest fern family with over 700 species occurring worldwide (Kramer & Viane 1990; Smith *et al.* 2006). This makes verification of identity or novelty challenging for unresolved Australian collections; the putative taxon must be compared with a large number of type specimens from overseas. In addition to the large species diversity in Aspleniaceae, hybridisation and polyploidy are frequently encountered (see Lovis 1977). Hybrids and polyploids are often morphologically distinct from parental lineages (Kramer & Viane 1990), obscuring their origins and giving the impression of completely new lineages.

While identification within Aspleniaceae is often difficult, members of the family are generally easy to distinguish from other families. Those in Aspleniaceae are distinguished by linear sori, clathrate scales on the stipes, and stipes which have two C-shaped vascular bundles at the base which unite apically up the stipe to form a 'butterfly-like' shape (Kato & Kramer 1990). Species of Aspleniaceae are morphologically most similar to some members of the Woodsiaceae *sensu* Smith *et al.* (2006) (=Athyriaceae *sensu* McCarthy (1998)), which also possess elongate indusiate sori. The majority of these Woodsiaceae species are most easily distinguished from Aspleniaceae by being large terrestrial plants; however, they are consistently distinguished by more subtle features such as differences in the arrangement of vascular bundles in the stipe, and by the possession of non-clathrate scales (Kato & Kramer 1990), which are often only obscurely differentiated from the clathrate scales observed in Aspleniaceae. Two Woodsiaceae genera occur in north-east Queensland: *Deparia* Hook. & Grev. and *Diplazium* Sw. *sensu lato* (including *Callipteris* Bory).

This study sequenced two chloroplast regions, *rbc*L and *trn*L-F, of a fresh collection of *Asplenium* sp. 'P.E.I. Road', in order to determine this taxon's affinity amongst the ferns, and to resolve its taxonomic status.

Materials and methods

Collections of *Asplenium* and *Diplazium* in Australian herbaria, and selected type material from extra-Australian herbaria were examined. One specimen of *Asplenium* sp. 'P.E.I. Road' was collected (*Ohlsen 461*, BRI, MELU) in the vicinity of the most recent P.E.I. Road collection (*Sankowsky & Sankowsky 2637*, BRI).

DNA isolation, amplification and sequencing.

DNA was extracted from 20 mg of silica gel-dried leaf tissue. Leaf tissue was ground using a mortar and pestle with the aid of acid washed grinding sand (Ajax Finechem, Australia). DNA was isolated from ground samples using a DNeasy Plant Mini Kit (QIAGEN, Germany), following the manufacturer's instructions. DNA was eluted in 100 µL of the supplied elution buffer.

The chloroplast DNA markers *rbc*L and *trn*L-F were sequenced. These regions were chosen because 1) both are routinely used in fern systematics, enabling comparison of sequences obtained from this species to those of many other species, and 2) effective phylogenetic placement (at least to genus level) can be achieved with both regions. *rbc*L is a gene enabling comparison across multiple plant lineages, and the *trn*L-F region contains an intron and intergenic spacer, which have faster mutation rates, enabling differentiation between closely related species and populations.

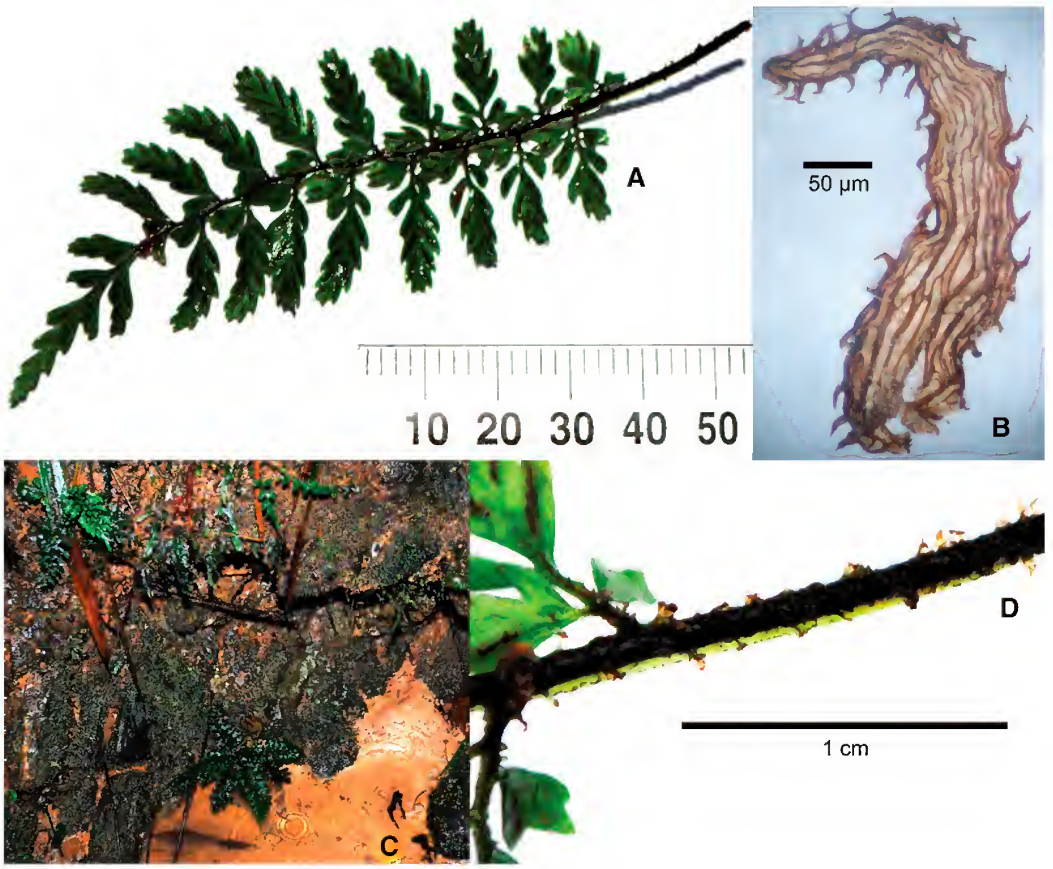

Fig. 1. ***Diplazium squamuligerum*** (syn. *Asplenium* sp. P.E.I. Road) from Topaz National Park, Atherton Tableland, Queensland (*Ohlsen 461 et al.* [BRI, MELU]). (a) a mature frond with elongate sori, (b) a fully developed scale from the base of the stipe, (c) *D. squamuligerum* in habitat (two plants are shown: top left, and bottom beside the creek pool), (d) detail of the rachis and stipe wing, and the protuberances, some with scales developing upon them.

Chloroplast DNA markers were amplified by Polymerase Chain Reaction (PCR), performed on a MyCycler thermal cycler (Bio-Rad, USA). Reaction mixtures comprised 5 µL of 5× MyTaq Reaction Buffer containing 5mM of each dNTP and 15 mM $MgCl_2$ (Bioline, Australia), 50 µg BSA (Thermo Fisher Scientific, Australia), 0.125 µL (0.625 Units) MyTaq DNA Polymerase (Bioline, Australia), 10 pmol of each primer, 2.0 µL of extracted DNA, and distilled water added to make a total volume of 25 µL. No amplification occurred without the addition of BSA. The *rbc*L gene was amplified using the primers ESRBCL1F (5'-ATG TCA CCA CAA ACG GAG ACT AAA GC-3') and ESRBCL1361R (5'-TCA GGA CTC CAC TTA CTA GCT TCA CG-3') (Schuettpelz & Pryer 2007). The *trn*L intron, *trn*L 3'-exon and *trn*L-F intergenic spacer were amplified using the primers F (5'-ATT TGA ACT GGT GAC ACG AG-3') (Taberlet *et al.* 1991) and Fern1 (5'-GGC AGC CCC CAR ATT CAG GGR AAC C-3') (Trewick *et al.* 2002). PCR thermocycling conditions involved an initial denaturation step of 95°C for 1 minute, followed by 33 cycles of 95°C for 1 minute, 55°C for 1 minute, and 65°C for 4 minutes, and a final extension time of 65°C for 5 minutes. DNA concentrations were quantified by electrophoresis against Hyperladder I and EasyLadder I (Bioline, Australia) and PCR products were purified using illustra ExoSTAR 1-step enzymatic purification (GE

Healthcare Life Sciences, UK). Purified PCR products were then sent to the Australian Genome Research Facility (AGRF), Melbourne Branch, where sequencing reactions, and capillary separation, using the 96-capillary analyser AB 3730*xl* sequencing platform, were performed.

Sequence editing, alignment, and analysis. Sequences were edited using Sequencher v. 3.0 (Gene Codes Corporation, Ann Arbor, MI, USA) and the NCBI nucleotide-nucleotide BLAST (blastn) tool (Altschul *et al.* 1997) was then used to evaluate the similarity of both *rbc*L and *trn*L-F sequences to existing sequences in GenBank. After the search using the BLAST tool was performed, available *rbc*L and *trn*L-F sequences of *Diplazium* species from GenBank were gathered (**Appendix 1**) and aligned manually in Se-Al Sequence Alignment Editor v. 2.0a11 (Rambaut 2002). Outgroup sequences were also gathered from GenBank (**Appendix 1**).

Parsimony analyses were run in PAUP* v 4.0β10 (Swofford 2000). Gap characters in the alignment were treated as a fifth character state. For multiple base indels, characters were excluded from analyses so that indels were represented only by a single gap character, when variability did not occur within indels. Question marks, the character recognised in PAUP for missing data, were used to fill gaps, where needed, when indels fell across otherwise variable regions of the alignment. A heuristic tree search was used, with delayed character-state optimization (DELTRAN) and starting trees obtained by a closest addition sequence followed by tree bisection-reconnection (TBR) branch swapping. Bootstrap support for tree nodes was determined for each analysis, with 100 replicates. Separate parsimony analyses were performed for each chloroplast DNA region. *Athyrium felix-femina* (L.) Roth was chosen as an outgroup, based on the sister relationship of *Athyrium* to *Diplazium* in past molecular phylogenies (Sano *et al.* 2000; Wang *et al.* 2003; Schuettpelz & Pryer 2007) and for the *rbc*L analysis, in which it is possible to align distantly related taxa, the more distantly related *Blechnum occidentale* L. and *Asplenium marinum* L. were also included as outgroups.

Species identification.
Online images of *Diplazium* types (B, MICH) were examined, to determine whether this taxon could be assigned to an existing *Diplazium* species, or if it was an undescribed species.

Common Abbreviations used in Specimen Citations

LA (Logging Area); NP (National Park).

Results

Searches using the BLAST tool of both *trn*L-F and *rbc*L sequences, determined that sequences from the P.E.I. Road specimen had the greatest similarity to species of *Diplazium* in the family Woodsiaceae. 37 *Diplazium* *rbc*L sequences were used to produce an alignment 1188 base pairs long, which contained 110 parsimonious characters. Two most parsimonious trees were obtained (length=398 steps, CI= 0.626) one of which is shown (**Fig. 2a**). This had a topology identical to the strict consensus tree, except for the placement of *D. doderleinii* (Luerss.) Mak., which in the consensus tree is placed in a polytomy with the clade of *D. amamianum* Tagawa + *D. hachijoense* Nakai and the clade of *D. taiwanense* Tagawa + *D. virescens* Kunze. 10 *Diplazium trn*L-F sequences were used to produce an alignment of 753 included base pairs, which contained 139 parsimonious characters. A single most parsimonious tree was obtained (length=302 steps, CI=0.831) (**Fig. 2b**). Maximum parsimony analyses of *rbc*L (**Fig. 2a**) and *trn*L-F (**Fig. 2b**) shows that the P.E.I. Road taxon is nested well within *Diplazium sensu lato.* Of all *Diplazium* species currently sequenced for *rbc*L, it is most closely related to *D. proliferum* (Lam.) Thouars. (=*Callipteris prolifera* (Lam.) Bory *sensu* Jones [1998]) with high bootstrap support (98%). It differs from *D. proliferum* by 12 base pairs in *rbc*L.

Inspection of *Diplazium* type material revealed that the P.E.I. Road taxon matches *Asplenium varians* var. *squamuligerum* Rosenst., from New Guinea, now treated as

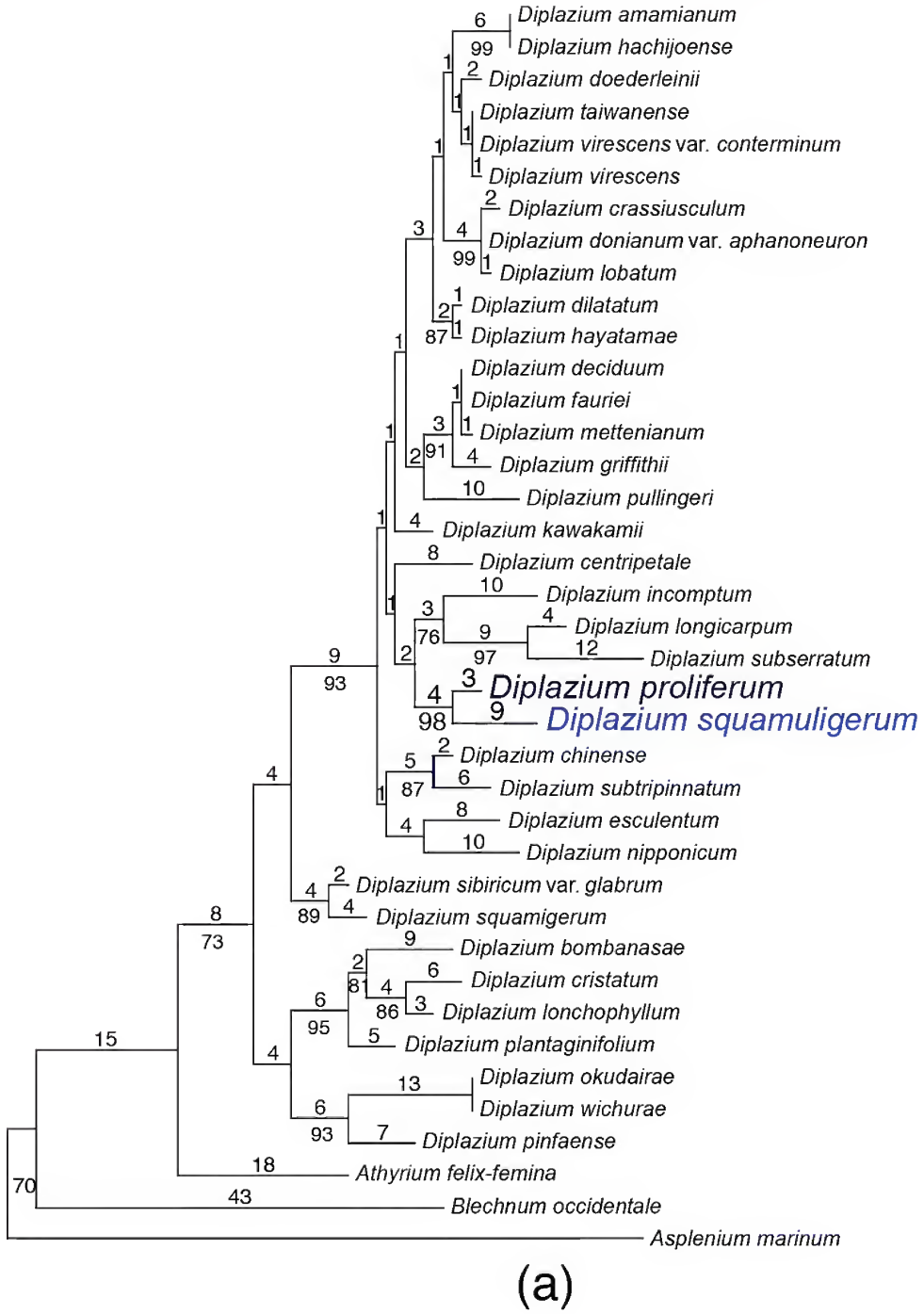

Fig.2a. Parsimony analyses of *rbc*L showing the phylogenetic position of Australian *Diplazium squamuligerum*. Branch lengths are given above braches and bootstrap support values greater than 70% are given below branches.

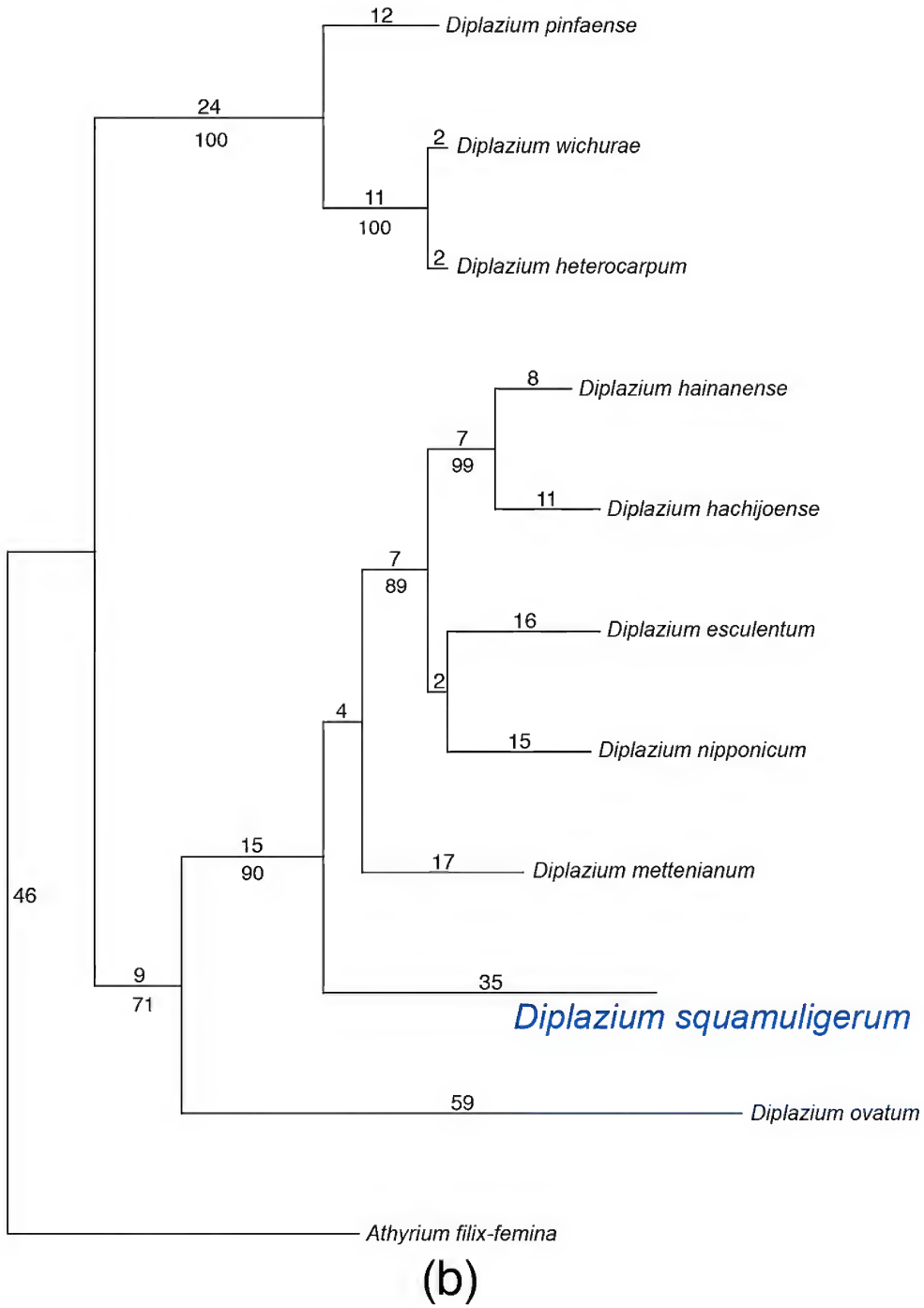

Fig.2b. Parsimony analyses of *trn*L-F. Branch lengths are given above braches and bootstrap support values greater than 70% are given below branches.

Diplazium squamuligerum (Rosenst.) Parris. The original diagnosis treated it as a variety of the unrelated African *Asplenium varians* Wall. ex Hook. & Grev. (Rosenstock 1913). The diagnosis is very brief, outlining only some immediately obvious features which distinguish *D. squamuligerum* from *A. varians*. Many of the morphological features that are quite distinctive are not mentioned. The following description describes *Diplazium squamuligerum* in greater detail, including several distinctive features overlooked by the earlier diagnosis.

Taxonomy

Diplazium squamuligerum (Rosenst.) Parris, *Kew Bull.* 41 (1): 69 (1986); *Asplenium varians* var. *squamuligerum* Rosenst., *Repert. Spec. Nov. Regni Veg.* 12: 528 (1913); *A. squamuligerum* (Rosenst.) Hieron, *Hedwigia* 61:5 (1919).**Type:** Papua New Guinea: Morobe Province: Sattelberg Hinterland, 1400–1500 m *[I.C.] Keysser 228*, April 1913 (holo: S, S-P-7625, online image!; iso: UC 378428, online image!; MICH 1190092, online image!).

Rhizome erect, to 1.5 cm tall, scaly; scales to 1 mm long, dark brown with toothed margins. Fronds arcuate, 5–15 cm long, 1.5–4 cm wide. Stipe 0.5–5 cm long, dark green, enveloped by green tissue which elongates to produce wings and protuberances; protuberances eventually bearing light brown scales to 1 mm long, with darker brown veins and bifid marginal teeth. Lamina bipinnate-tripinnatifid, 3–10 cm long, 1.5–4 cm wide, dark green above, paler below, occasionally proliferous from the rachis. Primary pinnae 5–25 mm long, 2–10 mm wide, most with an acroscopic secondary pinna to 5 mm long and an elliptic apical segment 5–10 mm long; margins serrate; veins free. Sori to 4 mm, elongate along most veins; indusium entire, narrow, light brown (**Fig. 1a, b, d**).

***Specimens examined*: Australia: Queensland.** Cook district: North Johnstone LA, July 1983, *Lockyer s.n.* (CANB); P.E.I. Road, Topaz NP, July 2005, *Sankowsky & Sankowsky 2637* (BRI); North Johnstone LA, Jan 2013, *Ohlsen 461 et al.* (BRI, MELU); Portion 545 Parish of Dirran, Mallan Road, July 1983, *Gray 3133* (CNS).

***Distribution and habitat*:** In Australia *Diplazium squamuligerum* is known only from two areas on the Atherton Tableland, north-east Queensland; however, it also occurs in Papua New Guinea. It grows in mixed mesophyll rainforest, on metamorphic rocks or between tree roots in volcanic soil, in steep embankments of small, slow-flowing creeks (**Fig. 1c**).

***Notes*:** Wings of the axes often become obscure when dried, but are obvious in fresh material.

Key to Australian species of *Diplazium* (naturalised taxa indicated *)

1 Veins anastomosing **2**
1. Veins free **5**

2 Lamina simple. . . . . **D. cordifolium**
2. Lamina pinnate to tripinnate **3**

3 Lamina pinnate, rachis proliferous . . . . . **D. proliferum** (syn. **Callipteris prolifera**)
3. Lamina bipinnate or tripinnate, rachis not proliferous **4**

4 Secondary pinnae 1–1.5 cm wide, margins incised more than half-way to the pinnule midvein. . . . . **D. dietrichianum**
4. Secondary pinnae 1.5–2.5 cm wide, very shallowly lobed . . . . . ***D. esculentum**

5 Lamina pinnate **6**
5. Lamina bipinnate or more divided **7**

6 Lamina apex a single pinna similar to lateral pinnae. . . . . **D. pallidum**
6. Lamina apex formed by reduction of lateral pinnae . . . . . **D. dameriae**

7 Fertile laminae < 250 mm long, stipe and rachises winged, wing extending to form scale bearing protuberances, pinnae with a basal acroscopic secondary pinna or lobe . . . . . **D. squamuligerum**
7. Fertile Laminae > 250 mm, stipe, rachis and pinnae not as above **8**

8 Lamina bipinnate **9**
8. Lamina tripinnate or more divided **10**

9 Basal lobes of secondary pinnae longest, abaxial surface of pinnae glabrous . . . . . **D. dietrichianum**
9. Basal lobes of secondary pinnae similar to or smaller than the rest, abaxial surface bearing red glandular hairs. . . . . **D. dilatatum**

10 Lamina pale green, pinnules less than 5 mm long and 3 mm wide . . . . . **D. assimile**
10. Lamina dark green, pinnules greater than 10 mm long and 4 mm wide **11**

11 Apex of pinnules acute to caudate . . . . . **D. bostockii**
11. Apex of pinnules obtuse. **12**

12 Pinnules of fertile lamina dissected < one third of the distance to the midvein, pinnules decurrent on basiscopic margin. . . . . **D. australe**
12. Pinnules of fertile lamina dissected > half-way to the midvein, pinnules not decurrent . . . . . **D. queenslandicum**

Discussion

The identification of the P.E.I. Road taxon as a species of *Diplazium* by chloroplast DNA sequence is also supported by morphology. Populations of *D. squamuligerum* in Australia have elongate sori and scales that are borne on small protuberances: both features typical of *Diplazium* (Jones 1998). The scales are characterised by bifid teeth on a darkened margin and conform to the 'Callipteris type' (**Fig. 1b**). This scale type is known only from the segregate genus *Callipteris* and a few other *Diplazium* species (Pachebo & Moran 1999; Pachebo & Moran 2003).

These specimens were repeatedly misidentified as a species of *Asplenium*, rather than being correctly identified as a *Diplazium*. Hence this study is another case which highlights the value of DNA sequences for phylogenetic placement and identification when morphology may be misleading (Gastony et al. 2001). It also begs caution in identifying species by overall morphology without close inspection of more subtle but taxonomically informative features such as scale characters.

Prior to this study, 12 species of *Diplazium* were known in Australia (one species, *D. esculentum* is naturalised). All of these *Diplazium* species are large terrestrials, with fronds over 50 cm long. The small size of *D. squamuligerum* is therefore unique amongst Australian *Diplazium*, and unusual amongst all *Diplazium* (Kato & Kramer 1990). Its position in the chloroplast phylogeny, as sister to *D. proliferum* is supported by its possession of the 'Callipteris type' scales, that are also possessed by *D. proliferum* (Jones 1998). Both *D. squamuligerum* and *D. proliferum* are also proliferous from the rachis, albeit rarely so in *D. squamuligerum*. Otherwise these species are quite dissimilar in general appearance. *D. proliferum* is a very large fern with pinnate fronds to over 2 metres in length whereas the fronds of *D. squamuligerum* are at least 2-pinnate and less than 15 cm long. *D. squamuligerum* also has free venation and winged axes (Fig. 1d); the latter feature is not shared with any other Australian *Diplazium* species.

The current phylogeny of *Diplazium* is limited in the number of species sampled. Chloroplast DNA sequences of only 38 species are publicly available, all of which

are incorporated in the phylogenies presented here. This is a low proportion of the 400 species of *Diplazium* in total (Kato & Kramer 1990). So it is highly likely that another unsampled species of *Diplazium* is more closely related to *D. squamuligerum* than *D. proliferum*, especially given the large number of base pair differences between the two species. Several *Diplazium* species, which occur in New Guinea, or possess the 'Callipteris type' scales, are yet to be sequenced, and may be more closely related.

Diplazium has received little attention from molecular study, as is demonstrated by the low number of sequences available on GenBank. Further molecular work, involving a more comprehensive sampling of species, is required in *Diplazium* not only to gain a better understanding of the systematics and biogeography of this genus, but also to aid taxonomic revision, particularly at the generic level. It has been suggested, based on a recent molecular study using a rather small number of species (Wang *et al.* 2003), that several genera which had been segregated from *Diplazium* be placed back into that genus. This included *Callipteris*, a genus still accepted in Australia (Jones 1998). However, revision of *Diplazium* cannot be completed until more species sampling is undertaken. The close relationship of *D. squamuligerum* to *D. proliferum* suggests that the 'Callipteris type' scale may define a monophyletic group. It has been suggested that this feature may be used to recircumscribe *Callipteris*, to include the few *Diplazium* species, such as *D. squamuligerum*, that have this scale type, and also have free venation (Pachebo & Moran 2003). However, the monophyly of all species possessing this scale type needs to be demonstrated before any revision is undertaken (Pachebo & Moran 2003).

Identification of this species as *D. squamuligerum* provides an additional example of a fern species that is localised in a few sites on the Atherton Tableland. Populations at Topaz NP are within close proximity to other localised fern species. They are within 3 km of the only known locality of *Hymenasplenium unilaterale* in Australia, and adjacent to one of approximately ten locations of *Dryopteris wattsii* M.McKeown, Sundue & Barrington. In addition to these exceptionally rare species, other uncommon fern species such as *Dicksonia herbertii* W.Hill, *Oleandra musifolia*, and *Pteridoblechnum acuminatum* (C.T.White & Goy) Hennipman and *P. neglectum* (F.M.Bailey) Hennipman also occur at or near the *D. squamuligerum* population localities. Likewise, the Maalan population is within 7 km of one of only three populations of *Asplenium normale* D.Don in Australia. The occurrences of multiple, very localised fern species near sites of *D. squamuligerum* highlights the high conservation priority that should be given to these areas, especially considering the high diversity of seed plant species also present. It also suggests that a number of equally localised species may have been lost due to vegetation clearing around these populations.

Diplazium squamuligerum is currently one of the most threatened fern species in Australia. While it is reserved in Topaz NP, all populations of this species are small in area and size and are particularly vulnerable to stochastic events. Periods of particularly high rainfall, with increased runoff due to surrounding cleared land, can swell the small creeks along which it occurs. Consequently plants face the danger of being uprooted from the creek embankments. This species would also be extremely susceptible to desiccation. It occurs in very high rainfall areas, and along small slow flowing creeks, that provide the constant soil moisture and high humidity that is probably required by the plant. Extended dry periods may reduce such small creeks and limit water access to plants. Such stochastic weather events are expected to become more extreme in the future with ongoing climate change (Abbs *et al.* 2006; Mpelasoka *et al.* 2008; Walsh *et al.* 2004).

The one collection from Papua New Guinea that exists in Australian herbaria (Brass 25731 [CANB]) was collected from Mt Pabinama, Normanby Island, which is 550 km south-east from the type locality, and suggests that *D. squamuligerum* is more widespread in Papua New Guinea.

A conservation status of Vulnerable is recommended for *D. squamuligerum* in accordance with the distribution and abundance characteristics of other taxa listed as Vulnerable under the Nature Conservation Act 1992 (Queensland), the Environment Protection and Biodiversity Conservation Act 1999 (Australian Commonwealth) and also in line with the criteria of the International Union for Conservation of Nature (IUCN). A conservation advice report is currently being prepared for *D. squamuligerum* in Australia.

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References

Abbs, D., Aryal, S., Campbell, E., McGregor, J., Nguyen, K., Palmer, M., Rafter, T., Watterson, I. & Bates, B. (2006). Projections of extreme rainfall and cyclones. CSIRO, Final report to the Australian Greenhouse Office.

Andrews, S.B. (1990). *Ferns of Queensland. A handbook to the ferns and fern allies*, 402–404. Queensland Department of Primary Industries: Brisbane, Australia.

Altschul, S.F., Madden, T.L., Schaffer, A.A., Zhang, J., Zhang, Z., Miller, W. & Lipman, D.J. (1997). Gapped blast and psi-blast: a new generation of protein database search programs. *Nucleic Acids Research* 25: 3389–3402.

Bell, G.H. (1998). Davalliaceae. In P.M. McCarthy (ed.), *Flora of Australia Ferns, Gymnosperms and Allied Groups* 48: 434–450. ABRS/CSIRO: Melbourne.

Brownsey, P.J. (1998). Aspleniaceae. In P.M. McCarthy (ed.), *Flora of Australia Ferns, Gymnosperms and Allied Groups* 48: 295–327. ABRS/CSIRO: Melbourne.

Gastony, G.J. & Johnson, W.P. (2001). Phylogenetic placements of Loxoscaphe thecifera (Aspleniaceae) and Actiniopteris radiata (Pteridaceae) based on analysis of *rbc*L nucleotide sequences. *American Fern Journal* 91: 197–213.

Hovenkamp, P.H. & Ho, B-C. (2012). A revision of the fern genus Oleandra (Oleandraceae) in Asia. *PhytoKeys* 11: 1–37.

Jones, D.L. (1998). Athyriaceae. In P.M. McCarthy (ed.), *Flora of Australia Ferns, Gymnosperms and Allied Groups* 48: 418–429. ABRS/CSIRO: Melbourne.

Kato, M. & Kramer, K.U. (1990). Subfamily Athyrioideae. In K.U. Kramer & P.S. Green (eds.), *The families and genera of vascular plants Pteridophytes and gymnosperms* 1: 130–144. Springer-Verlag: Berlin.

Kramer, K.U. & Viane, R. (1990). Aspleniaceae. In K.U. Kramer & P.S. Green (eds.), *The families and genera of vascular plants Pteridophytes and gymnosperms* 1: 52–56. Springer-Verlag: Berlin.

Lovis, J.D. (1977). Evolutionary patterns and processes in ferns. Advances in Botanical Research 4: 223–415.

McCarthy, P.M. (1998). *Flora of Australia Ferns, Gymnosperms and Allied Groups* 48. ABRS/CSIRO: Melbourne.

Mpelasoka, F., Hennessy, K., Jones, R. & Bates, B. (2008). Comparison of suitable drought indices for climate change impacts assessment over Australia towards resource management. *International Journal of Climatology* 28: 1283–1292.

Pachebo, L. & Moran, R.C. (1999). Monograph of the neotropical species of Callipteris with anastomosing veins (Woodsiaceae). *Brittonia* 51: 343–388.

—— (2003). Lectotypification of several names currently placed in Diplazium (Woodsiaceae). *American Fern Journal* 93: 90–92.

Parris, B.S. (1986). New combinations in filices. *Kew Bulletin* 41: 69–70.

Rambaut, A. (2002). 'Se-Al: sequence alignment editor'. Available at: http://tree.bio.ed.ac.uk/

Rosenstock, E. (1913). Filices novoguineenses Keysseranae, III. *Repertorium Specierum Novarum Regni Vegetabilis* 12: 524–530.

Sano, R., Takamiya, M., Ito, M., Kurita, S. & Hasebe, M. (2000). Phylogeny of the lady fern group, tribe Physematieae (Dryopteridaceae), based on chloroplast gene sequences. *Molecular Phylogenetics & Evolution* 15: 403–413.

Schuettpelz, E. & Pryer, K.M. (2007). Fern phylogeny inferred from 400 leptosporangiate species and three plastid genes. *Taxon* 56: 1037–1050.

Smith, A.R., Pryer, K.M., Schuettpelz, E., Korall, P., Schneider, H. & Wolf, P.G. (2006). A classification for extant ferns. *Taxon* 55: 705–731.

Swofford, D.L. (2000). *PAUP* 4.0: phylogenetic analysis using parsimony (*and other methods)*. Sinauer Associates: Sunderland, MA.

Taberlet, P., Gielly, L., Pautou, G. & Bouvet, J. (1991). Universal primers for amplification of three non-coding regions of chloroplast DNA. *Plant Molecular Biology* 17: 1105–1109.

Trewick, S.A., Morgan-Richards, M., Russell, S.J., Henderson, S., Rumsey, F.J., Pinter, I., Barrett, J.A., Gibby, M. & Vogel, J.C. (2002). Polyploidy, phylogeography and Pleistocene refugia of the rockfern Asplenium ceterach: evidence from chloroplast DNA. *Molecular Ecology* 11: 2003–2012.

Walsh, K.J.E., Nguyen, K.C. & McGregor, J.L. (2004). Finer-resolution regional climate model simulations of the impact of climate change on tropical cyclones near Australia. *Climate Dynamics* 22: 47–56.

Wang, M-L., Chen, Z-D., Zhang, X-C., Lu, S-G. & Zhao, G-F. (2003). Phylogeny of the Athyriaceae: evidence from chloroplast *trn*L-F region sequences. *Acta Phytotaxonomica Sinica* 41: 416–426.

Appendix 1. Chloroplast DNA sequences included in analyses, identified by GenBank accession numbers

Taxon	*rbc*L	*trn*L
Asplenium marinum L.	AF240647	-
Athyrium felix-femina (L.) Roth	FJ821348	HQ676519
Blechnum occidentale L.	U05909	-
Diplazium amamianum Tagawa	AB574961	-
D. bombanasae Rosenst.	EF463308	-
D. centripetale (Bak.) Maxon	EF463309	-
D. chinense (Bak.) C.Chr.	AB574962	-
D. crassiusculum Ching	AB574963	-
D. cristatum (Desr.) Alston	EF463310	-
D. deciduum N.Ohta & M.Takamiya	AB574964	-
D. dilatatum Blume	EF463311	-
D. doederleinii (Luerss.) Mak.	AB574966	-
D. *donianum* (Mett.) Tard var. *aphanoneuron* (Ohwi) Tagawa	AB574968	-
D. esculentum (Retz.) Sw.	U05619	AF514838
D. fauriei Christ	AB574970	-
D. griffithii (T.Moore) Diels	AB574971	-
D. hachijoense Nakai	EF463312	EU329111
D. hainanense Ching	-	AF515257

Taxon	*rbc*L	*trn*L
D. hayatamae N.Ohta & M.Takamiya	AB574973	-
D. heterocarpum Ching	-	-
D. incomptum Tagawa	AB574974	-
D. kawakamii Hayata	AB574975	-
D. lobatum (Tagawa) Tagawa	AB574976	-
D. lonchophyllum Kunze	U05920	-
D. longicarpum Kodama	AB574977	-
D. mettenianum (Miq.) C.Chr.	AB574978	AF515233
D. nipponicum Tagawa	AB574979	EU329110
D. okudairae Mak.	AB574980	-
D. ovatum Wall.	-	AF515232
D. pinfaense Ching	AB574981	AF515250
D. plantaginifolium (L.) Urb.	EF463314	-
D. proliferum (Lam.) Thouars	EF463918	-
D. pullingeri (Bak.) J.Sm.	AB574982	-
D. sibiricum (Turcz ex Kunze) Kurata in Namegata var. *glabrum* (Tagawa) Sa.Kurata	AB574983	-
D. squamigerum (Mett.) Christ	AB574984	-
D. squamuligerum (Rosenst.) Parris	KC900228	KC900229
D. subserratum (Blume) T.Moore	AB021721	-
D. subtripinnatum Nakai	AB574985	-
D. taiwanense Tagawa	AB574986	-
D. virescens Kunze var. *conterminum* (Christ.) Sa.Kurata	JN168017	-
D. virescens Kunze	EF463316	-
D. wichurae (Mett.) Diels	JN168018	AF515245

SHORT COMMUNICATION

New records for Queensland in *Lindernia* All. (Linderniaceae)

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The genus *Lindernia* All. (Linderniaceae Borsch, K.Müll. & Eb.Fisch.) is a pan-tropical genus represented in Australia by approximately 50 species. In Australia, many of the species are yet to be formally named, especially those from the Northern Territory.

During the current taxonomic revision of *Lindernia* in Queensland (Wannan in prep.) two new species have been recorded, namely: *Lindernia pusilla* (Willd.) Bold., which is a new record for Australia and *L. tectanthera* W.R.Barker, which is a new record for Queensland.

Lindernia pusilla (Willd.) Bold., *Zakfl. Java* 165 (1916); *Gratiola pusilla* Willd., *Sp. Pl. ed. 4*, 1(1): 105 (1797); *Pyxidaria pusilla* (Willd.) Kuntze, *Rev. Gen. Pl.* 2: 468 (1891); *Vandellia pusilla* (Willd.) Merr., *Philipp. J. Sci. Bot.* 7: 246 (1912). **Type:** India, *s.dat., s.coll.* (holo: B–W 377).

Weakly erect herb to 10 cm. Stems decumbent, densely pubescent with filamentous trichomes to 1 mm. Leaves simple opposite, very shortly petiolate or subsessile, petioles up to 1 mm. long, hirsute; lamina 5–15(20) mm long, 3–15 mm. wide, broadly ovate to subcircular to cordate, crenate-dentate, filamentous trichomes on both sides but more densely below; 5-nerved from base of leaf. Flowers axillary, in clusters of 1–3 per axil; pedicels slender, to 20 mm in flowers, 30 mm in fruit, with stalked glandular trichomes. Calyx deeply 5-lobed, almost to the base, lobes 3–4 mm long, single nerved and with stalked glandular and filamentous trichomes; margin finely serrate, scarious. Corolla 5–8.5 mm. long, white to pale violet to purple; tube externally glabrous or with sparse stalked glandular trichomes, internally with stalked glandular trichomes near antero-lateral ridges, otherwise glabrous; upper lip narrow emarginate; lower lip 3-lobed. Stamens 4, fertile, cohering in pairs; upper filaments 1–1.5 mm. long, glabrous; lower filaments 3–4 mm long, broadly geniculate just above the base, forming a 'webbed' bend. Ovary *c.* 1 mm; style 5–7 mm. Capsule subglobose to ovoid, more or less equal in length to the calyx. Seeds light brown, cylindric, 0.5 × 0.3 mm, with up to 8 longitudinal ribs. **Fig. 1.**

***Selected specimens examined*: Malaysia.** Lawn at Forestry Department Kuching Sarawak, Nov 1988, *Wannan UNSW16578* (CANB, NSW, UNSW). **Australia: Northern Territory.** 2 km NE of Port Bradshaw, Gove Peninsula, Sep 1987, *Russell-Smith 3380 & Lucas*, (AD, DNA). **Queensland.** Cook District: North of Coen, Jul 1999, *Wannan 1379* (BRI, CANB); North of Coen, Sep 2007, *Wannan 4855 & Graham* (BRI); *ditto loc.*, Jun 2009, *Wannan 5696 & Thompson* (CNS).

***Notes*:** *Lindernia pusilla* was first recognised in Australia from a collection made in 1999 just north of Coen beside the Peninsula Developmental Road, Queensland (*Wannan BSW1379).* Despite searches, no further localities have been recorded on Cape York Peninsula. During subsequent examination of *Lindernia* collections at AD a further collection was identified from the Northern Territory (*Russell-Smith 3380 & Lucas*). These sites remain the only known Australian localities.

According to Philcox (1968), *Lindernia pusilla* is widespread in the Indian subcontinent, China, Myanmar, Thailand and Malesia (Borneo, Celebes, Java, Malay Peninsula, Moluccas, Philippines, Sumatra and mainland New Guinea) up to an altitude of 1600 metres. It has also subsequently been

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Fig. 1. ***Lindernia pusilla*** (*Wannan 1379*: BRI). Photo: B. Wannan.

recorded from the Bismarck Archipelago of Papua New Guinea (Peekel 1984). The Australian material is a good match with the type and Malesian material (*cf. Wannan UNSW16578*) based on its morphology and, for the latter, seed anatomy.

Although a key to Queensland species will be provided in the revision (Wannan in prep.), *L. pusilla* can be distinguished from other Australian *Lindernia* by its multiple (pink) flowers per axil, long (to 30 mm) pedicels, and its stems pubescent with filamentous trichomes.

Lindernia tectanthera W.R.Barker, *J. Adelaide Bot. Gard.* 13: 86–87 (1990). **Type:** Western Australia. Kimberley Region: 23.3 km along King River Road, 25 April 1983, *R.M. Barker 284* (holo: AD).

Erect, sometimes decumbent, glabrous annual herb, 8–40 cm tall, with slender scapiform stems arising from a basal cluster of leaves; sometimes with stem branched in upper parts below the terminal inflorescence. Leaves at the base spathulate, 6–22 mm long, with the petiole 1–5 mm long, the blade ovate to obovate, sometimes narrowly so, 3–15 × 1.5–8 mm, entire, with midvein. Cauline leaves/ bracts subulate, 1–4 mm × 1–2 mm. Inflorescence terminal racemes or panicles; pedicels 5–32 mm at anthesis and erect, 15–40 mm in fruit and sometimes deflexed. Calyx 2–4.5 mm long; sepals 5, equal, divided almost to base, triangular, 3-nerved, often reddened. Corolla 2-lipped, with internal longitudinal flaps enclosing stamens and style; stalked glandular trichomes externally; white, with purple or mauve; tube 6–7 mm; upper lip recurved, 1.5–2 mm long, shallowly emarginate; lower lip widely spreading, 4–6.5 mm long, the lobes shallowly emarginate, the mid lobe wider than the laterals. Stamens with upper 2 stamens functional, filaments c. 1 mm; anthers 0.5–0.8 mm long, yellow,

Fig. 2. ***Lindernia tectanthera*** (*Wannan 6291 & Trenerry*: BRI). Photo: B. Wannan.

with 2 locules end to end, approximately 180° divergent; lower stamens sterile, anthers represented by 2 appendages geniculate at summit, proximally thick, near the apex often bearing a minute anther vestige. Ovary 1–1.5 mm, glabrous, style *c.* 5 mm, glabrous. Capsule ovoid, 4–5 × 2.5 mm, thin-walled, yellow-brown; seeds broad obovoid to oblong-ellipsoid, 0.3–0.35 × 0.2–0.25 mm, light brown, with 4 longitudinal angles and 4–6 transverse ridges. **Fig. 2.**

***Selected specimens examined*: Western Australia.** 3 km S of Pitta Creek near Prince Regent River, Jul 2009, *Wannan 5740* (BRI, CNS, NSW, PERTH); Drysdale River NP, Jul 2012, *Wannan 6563 & Wardrop* (CNS, PERTH). **Queensland**. Cook District: Sand Ridge, Staaten River NP, Jan 2003, *Fox IDF2002* (BRI); Wrotham Park, Jul 2011, *Wannan 6114* (BRI); Gamboola, Aug 2011, *Wannan 6291 & Trenerry* (NSW), *Wannan 6298 & Trenerry* (BRI).

Notes: *Lindernia tectanthera* was first described from the Kimberley region of Western Australia (Barker 1990). This species has been recently confirmed from west of Chillagoe in Queensland and is a good match with material from the Kimberley including the holotype, based on morphology and seed anatomy. Examination of Fox IDF2002 (Staaten River NP) has shown it to be also *L. tectanthera*. Queensland specimens of this taxon have been previously incorrectly determined as *Lindernia lobelioides* (F.Muell.) F.Muell., a Northern Territory species.

Lindernia tectanthera has been recorded widely from the Top End and Kimberley regions. The species typically occurs in moist areas often on the margin of sandy rises. It is distinguished from other Queensland species by its usual basal rosette of leaves and its upper corolla with a longitudinal flap which encloses the anthers and style.

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References

Barker, W.R. (1990). New taxa, names and combinations in *Lindernia*, *Peplidium*, *Stemodia* and *Striga* (Scrophularlaceae) mainly of the Kimberley Region, Western Australia. *Journal of the Adelaide Botanic Gardens* 13: 79–93.

Peekel, P.G. (1884). *Flora of Bismarck Archipelago for Naturalists*. Translated by E.E. Henty. Office of Forests, Division of Botany: Lae, Papua New Guinea.

Philcox, D. (1968). Revision of the Malesian species of *Lindernia* All. (Scrophulariaceae). *Kew Bulletin* 22: 1–72.

Status and lectotypification of *Craspedia gracilis* Hook.f. (Asteraceae: *Gnaphalieae*)

Andrew C. Rozefelds

Summary

Rozefelds, A.C. (2013). Status and lectotypification of *Craspedia gracilis* Hook.f. (Asteraceae: *Gnaphalieae*). ***Austrobaileya* 9(1): 130–135**. The identity of *Craspedia gracilis* Hook.f. is determined and it is shown to be conspecific with *C. coolaminica* J.Everett & Joy Thomps. which, being the younger name, is therefore placed in synonymy. The identity of *Craspedia richea* var. *linearis* Hook.f. is also resolved and it is shown to be a synonym of *C. gracilis*. Lectotypes of *C. gracilis* and *C. richea* var. *linearis* are designated and illustrated.

Key Words: Asteraceae, Gnaphalieae, *Craspedia, Craspedia coolaminica, Craspedia gracilis, Craspedia richea* var. *linearis,* Australia flora, Tasmania flora, taxonomy, billy buttons

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Introduction

Previous studies of *Craspedia* G.Forst. by Rozefelds (2002) and Rozefelds *et al.* (2011), have resolved the nomenclature of species of *Craspedia* described from Tasmania; however, the status of two taxa described by Hooker (1847), *C. gracilis* Hook.f. and *C. richea* Cass. var. *linearis* Hook.f, has been unclear.

Cassini (1818) recognised that *Richea glauca*, described by Labillardière (1800) from Tasmania, should be transferred to *Craspedia*. His new combination, *Craspedia richea* Cass.; however, is a *nomen illegitimum*, as recognized by Chapman (1991), since it was based on *Richea glauca* Labill. whose epithet should have been adopted. Sprengel (1826) successfully transferred this species to *Craspedia*, i.e. *C. glauca* (Labill.) Sprengel.

Hooker (1847) described *Craspedia gracilis* Hook.f. from the Middlesex Plains [Tasmania], although he later, in '*Flora Tasmaniae'*, reduced *C. gracilis* to a variety, *C. richea* var. *gracilis* Hook.f. Curtis (1963: 346) recognised that '*C. glauca* included several further spp. and varieties [that] have been named'. She recognised four varieties including the new combination *C. glauca* var. *gracilis*, but as the original reference and dates of publication for this taxon were not cited, it is invalid (Chapman 1991).

Hooker (1847) also recognised two new varieties of *Craspedia richea*. The status of *C. richea* var. *glabrata* Hook.f. from the western mountains of Tasmania, was examined by Rozefelds (2002) and a new combination *C. glabrata* (Hook.f.) Rozefelds was proposed. The status of *C. richea* var. *linearis* Hook.f. from the western mountains of Tasmania is reviewed herein. Curtis (1963) did not discuss the status of this variety.

Craspedia coolaminica J.Everett & Joy Thomps. was described from material collected on mainland Australia and Tasmania, but the description of this species overlaps with that of both *C. richea* var. *linearis* and *C. gracilis*. To resolve the status of these taxa described by Hooker (1847), cibachromes of early Tasmanian collections of *Craspedia gracilis* and *C. richea* var. *linearis,* held at Kew, were obtained; and from the study of these images it is proposed that *C. coolaminica* and *C. richea* var. *linearis* are placed in synonymy under *C. gracilis*.

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Taxonomy

Craspedia gracilis Hook.f.

Craspedia gracilis Hook.f., *Lond. J. Bot.* 6: 118 (1847); *C. richea* Cass. [*nom. illeg.*] var. *gracilis* (Hook.f.) Hook.f., *Flora Tasmaniae* 3: 197 (1857); *C. glauca* var. *gracilis* (Hook.f.) W.M.Curtis *comb. invalid.*, *The Student's Flora of Tasmania* 2: 247 (1963). **Type citation:** "Middlesex plains; *Gunn*". **Type:** Tasmania. Middlesex Pl., 15 February 1837, [*R.C.*]*Gunn 835/1837* (lecto [here designated]: K *n.v.*, cibachrome at HO!). The specimen associated with the label on the right hand side of the plate is the lectotype (**Fig. 1**).

Craspedia richea Hook.f. [*nom. illeg.*] var. *linearis* Hook.f., *Lond. J. Bot.* 6: 118 (1847); *C. richea* Cass. [*nom. illeg.*] var. β *linearis* Hook.f., *Flora Tasmaniae* 3: 197 (1857). **synon. nov. Type citation:** "Western Mountains; *Gunn*". **Type:** Tasmania. Western Mountains, 17 February either 1842 or 1843 (as the year is not consistent on the label), [*R.C.*] *Gunn 1160/1842* (lecto [here designated]: K *n.v.*, cibachrome at HO!). The more complete specimen on the left hand side of the plate is the lectotype (**Fig. 2**).

Craspedia coolaminica J.Everett & Joy Thomps., **synon. nov.**, *Telopea* 5: 45 (1992). **Type:** New South Wales. Southern Tablelands: Happy Jacks, Snowy Mountains, near Happy Jacks Road, above sheep yard, 27 January 1964, *M.E.Phillips 20419* (holo: NSW *n.v.*; iso: CBG *n.v.*)

***Typification*:** In describing *Craspedia gracilis*, Hooker (1847) did not specify a numbered collection of Gunn's. The specimen *Gunn 835/1837* from Middlesex Plains comprises three individual plants and was examined by Hooker; hence, it is an appropriate choice for lectotypification of the name. A lectotype is chosen based on the right-hand specimen closest to the collector's label.

Craspedia richea var. *linearis* was described by Hooker (1847) as having narrowly linear leaves with arachnose hairs and known from the "Western Mountains", and although no specific locality, nor collector number were recorded a specimen in K, *Gunn 1160/1842*, dated 18 February 1843, is consistent with the limited published information. Notes on this herbarium sheet, in Ronald Campbell Gunn's handwriting, record it as *Craspedia*, but the note has been annotated by a later author with '*richea* var. *linearis*'. The narrowly linear leaves and silvery grey foliage are consistent with *C. gracilis*. Gunn's notes on the type of *C. richea* var. *linearis* records the florets as orange (**Fig. 2**), and while no orange-floreted species are known from Tasmania, the bright yellow flowers of *C. gracilis* approach an orange colour (**Fig. 3**). The combination, *C. richea* var. *linearis*, was only used by Hooker, so it seems very likely that this collection was examined by Hooker, and as it comes from the "Western Mountains" and was collected by Gunn, it is an appropriate choice for lectotypification of this name. As the herbarium sheet includes two similar-sized specimens and the right-hand specimen is more complete, it is designated as the lectotype.

Hooker (1857) in *Flora Tasmaniae*, considered *C. richea* var. β *linearis* as being restricted to the Western Mountains and referred a second collection (*Gunn 1160*) from Arthurs Lake to this variety. This collection (*Gunn 1160*) comprises four individual plants; all have long narrow silvery grey leaves with finely appressed hairs, and with arachnose hairs on the margin and are consistent with *C. gracilis* as defined herein.

Mainland Australian and Tasmanian populations of *Craspedia gracilis*

Craspedia gracilis as defined here occurs in subalpine communities in New South Wales, Victoria and Tasmania (Everett & Thompson 1992; Schmidt-Lebuhn & Milner 2013; Rozefelds *pers. obs.*). Like many species of *Craspedia*, plants are often morphologically variable, with the size of the plants and the various organs (leaves, scapes, bracts on scape and compound head) phenotypically plastic. Material from Tasmania is variable in size from small herbs (like the type), to large, robust specimens 60 cm high (Rozefelds *pers. obs.*). The mainland material show a similar variation in size (Everett & Thompson 1992) and no morphological differences were noted

Fig. 1. Lectotype of ***Craspedia gracilis*** Hook.f. (arrowed), *Gunn 835/1837* (K). The lectotype shows the typical narrow linear silvery grey leaves, fine hairs and secondary veins are clearly evident on the underside of the leaves. Reproduced by kind permission of the Board of Trustees of the Royal Botanic Gardens, Kew.

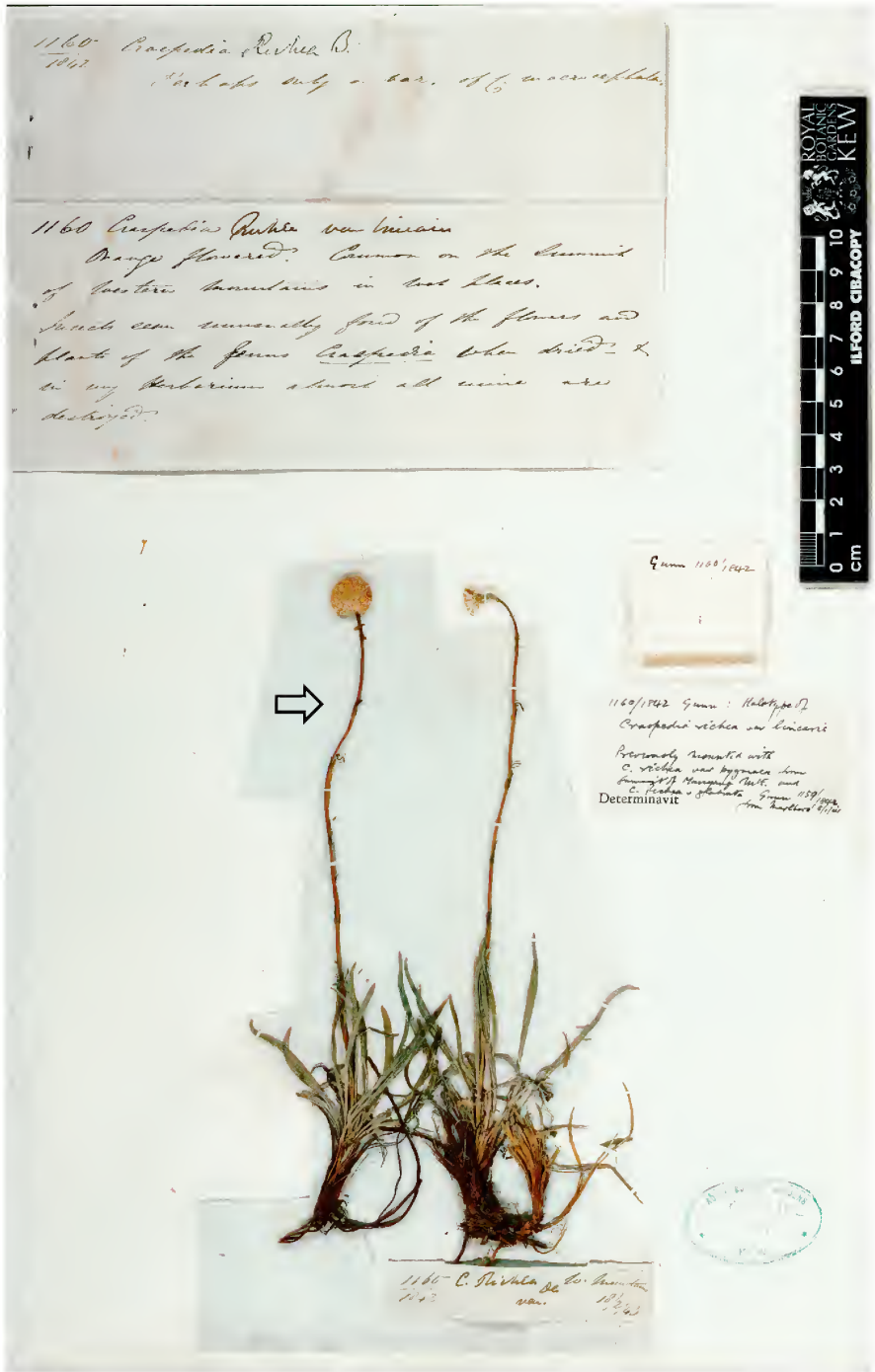

Fig. 2. Lectotype of ***Craspedia richea*** Cass. var. β *linearis* Hook.f. (arrowed), *Gunn 1160* (K). Reproduced by kind permission of the Board of Trustees of the Royal Botanic Gardens, Kew.

Fig. 3. Floret colour in ***Craspedia gracilis*** Hook.f (left hand inflorescence) compared with *C. rosulata* Rozefelds & A.M.Buchanan (right hand inflorescence).

between these mainland Australian and Tasmania populations by these authors in their original description.

Sequence data for mainland Australian and Tasmanian samples of *C. gracilis* (i.e. *C. coolaminica* in Ford *et al.* 2007) showed no variation in ITS, seven base differences in ETS, and in *psbA-trnH* there were two base differences and also two deletions in the Tasmanian specimen (Kerry Ford, *pers. comm.* 2013). There seems little justification based upon the current molecular data, and the overall similarities in morphology to support separation of mainland Australian and Tasmanian populations. As the two samples of *C. gracilis* were sister to each other in Ford *et al.* (2007) analysis, it also becomes an arbitrary decision, in a phylogenetic sense, as to whether they are considered conspecific or sister species.

Discussion

The lectotype of *Craspedia gracilis* Hook.f. (*Gunn 835/1837*) has long linear, narrowly lanceolate leaves, fine appressed hairs that impart the silver grey foliage, secondary veins clearly visible on the underside of the leaves due in part to the appressed hairs on the veins, and arachnose hairs along the leaf margins.

The distinguishing features of *Craspedia coolaminica* J.Everett & Joy Thomps. (Everett & Thompson 1992; Rozefelds *et al.* 2011) easily distinguish this species from others in Tasmania, *viz.* distinctive basal rosette of long linear to narrowly attenuate silvery grey leaves that have a dense covering of long, fine appressed hairs, conspicuous secondary veins on the abaxial leaf surface, yellow corolla and mid-summer flowering (December–February). As no characters have been recognised that separate these taxa apart, I conclude that *C. coolaminica* and *C. richea* var. *linearis* are both synonyms of *C. gracilis*.

Dawson *et al.* (1999) attributed a chromosome count of $2n$=44 for *Craspedia gracilis* (as *C. glauca*; Kerry Ford *pers. comm.* 2010). Putative hybrids have been noted between *C. gracilis* and the typically earlier flowering *C. rosulata* Rozefelds & A.M.Buchanan which is sympatric with this species at Miena, Central Plateau and the two species overlap slightly in flowering time. Putative hybrids are robust plants and have bright yellow florets like *C. gracilis*, rather than the light yellow of *C. rosulata*, but lack the conspicuous silver grey indumentum of *C. gracilis*.

Acknowledgements

I thank Alex Chapman in obtaining cibachromes of the relevant collections, Kerry Ford for advice on molecular data, and Alex Buchanan for his help and interest in the project. **Fig. 1**. and **Fig. 2** are reproduced by kind permission of the Board of Trustees of the Royal Botanic Gardens, Kew.

References

Cassini, A.H.G. de (1818). Craspédie, Craspedia. In *Dictionnaire des sciences naturelles, dans lequel on traite méthodiquement des différens êtres de la nature*. Second Edition. F.G. Levrault: Strasbourg/ Le Normant: Paris.

Chapman, A.D. (1991). *Australian Plant Name Index A-C*. Australian Biological Resources Study: Canberra.

Curtis, W.M. (1963). *The Student's Flora of Tasmania, Part 2*. Government Printer: Hobart.

Dawson, M.I., Breitwieser, I. & Ward, J.M. (1999). Chromosome numbers in *Craspedia*, *Ewartia* and *Pterygopappus* (Compositae: Gnaphalieae). *Australian Systematic Botany* 12: 671–674.

Everett, J. & Thompson, J. (1992). New alpine and subalpine species in *Craspedia sens. strict*. (Asteraceae: Gnaphalieae). *Telopea* 5: 45–51.

Ford, K.A., Ward, J.M., Smissen, R.D., Wagstaff, S.J., Breitwieser, I. (2007) Phylogeny and biogeography of *Craspedia* (Asteraceae: Gnaphalieae) based on ITS, ETS and *psbA-trnH* sequence data. *Taxon* 56: 783–794.

Hooker, J.D. (1847). Florae Tasmaniae Spicilegium or Contributions towards a Flora of Van Diemens Land. *London Journal of Botany* 6: 106–125.

Hooker, J.D. (1857). *Botany of the Antarctic Voyage of H.M. Discovery ships Erebus and Terror in the years 1839–1843. Vol. 3. Flora Tasmaniae*. Lovell Reeve: London.

Labillardière, J.J.H. de (1800). *Relation du voyage a la recherche de La Pérouse, fait par ordre de L'assemblée Constituante, pendant les annies 1791, 1792, et pendants 1ere la 2de année de la Republique Francoise*. 2 Vols. H.J. Jansen: Paris.

Rozefelds, A.C. (2002). A new species and new combination in *Craspedia* (Asteraceae) from Tasmania. *Telopea* 9: 813–820.

Rozefelds, A.C., Buchanan, A.M. & Ford, K.A. (2011). New species of *Craspedia* (Asteraceae: Gnaphalieae) from Tasmania, and determination of the identity of *C. macrocephala* Hook. *Kanunnah* 4: 93–116.

Schmidt-Lebuhn, A.N. & Milner, K.V. (2013). A quantitative study of morphology in Australian *Craspedia* (Asteraceae: Gnaphalieae). *Australian Systematic Botany* 26: 238–254.

Sprengel, C.P.J. (1826). *Systema Vegetabilium 3*. Gottingae sumtibus librariae: Dieterichlanae.

Craspedia uniflora G.Forst. (Asteraceae) is a New Zealand endemic and not part of the Australian flora

Alexander N. Schmidt-Lebuhn

Summary

Schmidt-Lebuhn, A.N. (2013). *Craspedia uniflora* G.Forst. (Asteraceae) is a New Zealand endemic and not part of the Australian flora. ***Austrobaileya* 9(1): 136–139.** Specimens identified as *Craspedia uniflora* from Australia in the Queensland Herbarium are shown to have been misidentified and this species should therefore be deleted from both the *Census of the Queensland Flora* and the *Australian Plant Census*. The absence of any Australian material of this species in Australian herbaria also indicates that *C. uniflora* is a New Zealand endemic. Four species of *Craspedia* are identified as occurring in Queensland, *C. canens* J.Everett & Doust, *C. haplorrhiza* J.Everett & Doust, *C. paludicola* J.Everett & Doust (syn. *C.* sp. (Girraween NP S.T.Blake 23643)) and *C. variabilis* J.Everett & Doust, and a key to these species is provided.

Key Words: Asteraceae, Compositae, Gnaphalieae, Australian Plant Census, Census of the Queensland Flora, *Craspedia*, *Craspedia canens*, *Craspedia haplorrhiza*, *Craspedia paludicola*, *Craspedia uniflora*, *Craspedia variabilis*, identification key

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Introduction

Craspedia G.Forst. (Asteraceae, Gnaphalieae) is a genus of *c.* 20 Australian and at least 6 New Zealand species of mostly perennial rosette plants bearing yellow, white or orange flowers in solitary compound heads on leafy scapes. Although found in all states of Australia except the Northern Territory, *Craspedia* is most diverse in subalpine to alpine regions of the south-eastern mainland and Tasmania.

Craspedia was described by Forster (1786) with one species, *C. uniflora* G.Forst. from New Zealand. Over the following two hundred years, several other species were described from New Zealand and Tasmania but only one from the Australian mainland (see Schmidt-Lebuhn & Milner 2013 for an overview), so that mainland specimens were often haphazardly referred to species from New Zealand and Tasmania, especially *C. uniflora* and *C. glauca* (Labill.) Spreng. Curtis (1963) did not consider *C. uniflora* to occur in Tasmania, while Stanley & Ross (1986) used the name for all specimens of *Craspedia s.str.* in south-eastern Queensland (the other two species they treated under *Craspedia* are now assigned to *Pycnosorus* Benth. which is characterized by sessile partial heads, yellow phyllaries and pappus, and a different base chromosome number; Everett & Doust 1992a).

Recent taxonomic or floristic treatments of *Craspedia* in Tasmania and the Australian mainland did not mention the species (Everett & Doust 1992b, c; Everett & Thompson 1992; Everett 1999; Costin *et al.* 2000; Rozefelds 2002; McDougall & Walsh 2008; Rozefelds *et al.* 2011). Most Australian specimens formerly identified as *C. uniflora*, including all those at CANB/CBG, have been assigned to species described in these recent studies. However, *C. uniflora* is still listed in the latest *Census of the Queensland Flora* (Bostock & Holland 2010) and in the *Australian Plant Census* (CHAH 2011) as occurring in all states except the Northern Territory. No nationwide taxonomic treatment of *Craspedia* is currently available.

Ford *et al.* (2007) demonstrated that the New Zealand species of *Craspedia* form a monophyletic group nested in the Australian representatives of the genus and thus are likely to represent the descendants of a single long

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distance dispersal event with no subsequent re-colonization of Australia. Because the New Zealand lineage has diversified into at least six species since its arrival (Allan 1961), it appears *a priori* unlikely that a contemporary species such as *C. uniflora* would be found on both sides of the Tasman Sea.

In this paper the status of *Craspedia uniflora* in Australia is examined to clarify whether Australian specimens identified as this species were merely overlooked when the taxonomy of Australian *Craspedia* was updated or whether at least some of them are conspecific with those from New Zealand. A recent quantitative study of morphological characters in the genus aimed to include specimens from all formally described native Australian species (Schmidt-Lebuhn & Milner 2013), and it was therefore important to determine whether *C. uniflora* needed to be included.

Materials and methods

All specimens labelled as *Craspedia uniflora* were requested as a loan from BRI, and a photograph of the type of the species was obtained from K. The morphology of the type as discernible from the photograph, the morphology of selected New Zealand specimens and the description of *C. uniflora* by Allan (1961) were compared against the morphology of Australian specimens previously identified as *C. uniflora* and the descriptions of and keys to Australian species (in particular Everett & Doust 1992a; Everett & Thompson 1992). The results of the quantitative analyses by Schmidt-Lebuhn & Milner (2013) were also taken into account.

Common abbreviations in the specimen citation include National Park (NP). All specimens have been seen unless indicated *n.v.*

Results

As circumscribed by Allan (1961), *Craspedia uniflora* of New Zealand is a heterogeneous species of four varieties occurring from coastal rock crevices to subalpine herb-fields. It is characterized by a very distinctive margin of tangled long white hairs around the leaves but overall plant size, glomerule size and flower colour are variable (yellow or white in the latter case). Under the typical variety, the type specimen at K is described as having leaves obovate- to lanceolate-spathulate, *c.* 7 × 1.5 cm, scapes *c.* 12 cm long and glomerules of *c.* 1.5 cm diameter, values that are rather small for a *Craspedia*. Visual examination of the photograph of the type showed it to match this description, with the single glomerule *c.* 1.4 cm in diameter and the longest intact leaf *c.* 6 cm long. A very distinctive margin of white hairs around the rosette and scape leaves is clearly visible.

No Australian specimens of *Craspedia* are consistent with the above morphology and descriptions. The only native species of similar stature as the type of *C. uniflora* are *C. alba* J.Everett & Joy Thomps., *C. glabrata* (Hook.f.) Rozefelds and *C. rosulata* Rozefelds & A.M.Buchanan, but all of them differ from this species especially in regard to the indumentum. Whereas *Craspedia lamicola* J.Everett & Joy Thomps. has a margin of hairs superficially similar to that of *C. uniflora* around otherwise glabrous to subglabrous leaves it is a much more robust plant restricted to wet alpine habitats with significantly larger scapes, leaves and glomerules.

Craspedia specimens from Queensland previously identified as *C. uniflora* were referable to *C. canens* J.Everett & Doust, *C. haplorrhiza* J.Everett & Doust, *C. paludicola* J.Everett & Doust and *C. variabilis* J.Everett & Doust. The species of *Craspedia* in Queensland can be determined with the following key, with the caveats that more work is needed to understand the circumscription and taxonomy of what is currently called *C. canens* and that *C. variabilis* may ultimately turn out to be a synonym of Tasmanian *C. glauca*. (Schmidt-Lebuhn & Milner 2013).

Key for the identification of *Craspedia* species that occur in Queensland

1 Plants short-lived, with a single tap-root . . . . . **2. C. haplorrhiza**
1. Plants perennial, with numerous secondary roots **2**

2 Tall plants up to 75 cm, with subglabrous to glabrous leaves, growing in swamps or drainage lines . . . . . **3. C. paludicola**
2. Smaller plants usually only to 50 cm, with hairy leaves, growing in drier habitats **3**

3 Leaves with woolly indumentum . . . . . **1. C. canens**
3. Leaves with robust septate indumentum and often with glands but not woolly . . . . . **4. C. variabilis**

Taxonomy

1. Craspedia canens J.Everett & Doust, *Telopea* 5: 37 (1992). **Type:** New South Wales. Central Tablelands: Wingecarribee [Wingicarribee] Swamp, 26 October 1971, *L.A. Craven 1981* (holo: NSW 221409 *n.v.*; iso: CANB; L *n.v.*).

***Additional specimens examined*: Queensland.** Darling Downs District: Stanthorpe, Feb 1916, *Wright s.n.* (BRI [AQ247074]); Stanthorpe, *s.dat.*, *Davidson s.n.* (BRI [AQ247073, 247077]); "The Junction track", Girraween NP, Oct 1974, *McDonald 467* (BRI); **Victoria.** Port Phillip, *s.dat.*, *Mossman 321* (BRI).

***Note*:** *Mossman 321* is very small and glabrescent, showing few of the diagnostic woolly hairs.

2. Craspedia haplorrhiza J.Everett & Doust, *Telopea* 5: 37 (1992). **Type:** New South Wales. Far South Western Plains: southern crossroad, north of Ranger's Station, Kinchega National Park, 12 September 1989, *A. Denham 39* (holo: NSW *n.v.*; iso: AD *n.v.*).

***Specimens examined*: Queensland.** Darling Downs District: 10 miles [16.6 km] SE of St George, Aug 1947, *Everist 3137* (BRI); **New South Wales.** *c.* 56 km S of Walgett, Lightning Ridge/Angledoon Road, Sep 1989, *White s.n.* (BRI [AQ504366]).

3. Craspedia paludicola J.Everett & Doust, *Telopea* 5: 35 (1992). **Type:** Victoria. Top End Reference Area Barmah State Park, Murray Valley Study Area Sector: F, sub-block: 41B, 28 September 1985, *A.C. Beauglehole 81321* (holo: MEL 681491 *n.v.*; iso: CANB; HO *n.v.*, NSW *n.v.*).

Craspedia sp. (Girraween NP S.T.Blake 23643), **synon. nov.** (Bostock & Holland 2007, 2010).

***Additional specimens examined*: Queensland.** Darling Downs District: About 7 miles [11 km] E of Wyberba, Oct 1958, *Pedley 297* (BRI); Girraween NP near Wyberba and Wallangarra, Nov 1971, *Blake 23643* (BRI); Racecourse Creek, Dingo Swamp, Girraween NP, Aug 1995, *Forster PIF17626* (BRI, CANB).

Notes: The loan made available by BRI also included several additional specimens not previously identified as *C. uniflora*, among them three sheets of the undescribed phrase name taxon *Craspedia* sp. (Girraween NP S.T.Blake 23643) (Bostock & Holland 2007, 2010; CHAH 2011). They do not differ in any significant way from *C. paludicola* J.Everett & Doust, especially considering the morphological variability of the latter species over its range on both sides of the Bass Strait. Although *Pedley 297* is an unusually small plant, its glabrous leaves and the habitat are typical of *C. paludicola*.

4. Craspedia variabilis J.Everett & Doust, *Telopea* 5: 36 (1992). **Type:** South Australia. South Eastern Region: *c.* 15 km south-east of Mt Burr Township, 7 September 1966, *I.B. Wilson 511* (holo: AD *n.v.*; iso: CANB).

***Additional specimens examined*: Western Australia.** Mundaring Weir, Aug 1926, *Bick s.n.* (BRI [AQ247068]); Dalyup, 30 miles [50 km] W of Esperance, Sep 1971, *Scarth-Johnson 820* (BRI). **Queensland.** Darling Downs District: Cons Plain, NE of Killarney, Oct 2000, *Bean 16897* (BRI); Killarney, Sep 1937, *Schindler 5* (BRI). Moreton District: turnstile gate above Grace's Hut, near Mt Barney, *s.dat.*, *Leiper s.n.* (BRI [AQ584399]). **New South Wales.** 7.4 km along Cochrane Road, Carrai NP, W of Kempsey, Dec 2007, *Bean 27170* (BRI, CANB). **Victoria.** Melbourne, *sine coll. s.n.* (BRI [AQ247063]). **South Australia.** Near Kapunda, in 1888, *Bailey s.n.* (BRI [AQ247062]); Eyre Peninsula Region, Marble Range, slopes of North Block, Sep 1979, *Weber 6018* (BRI).

Discussion

No Australian specimen previously labelled as *C. uniflora* was found to be consistent with the type or with descriptions (Allan 1961) and herbarium vouchers from New Zealand. *Craspedia uniflora* therefore is endemic to New Zealand, and the name should be removed from the *Census of the Queensland Flora* and the *Australian Plant Census*.

This study shows that four species of *Craspedia s.str.* occur in Queensland: *C. canens*, *C. haplorrhiza*, *C. paludicola* and *C. variabilis*. *Craspedia haplorrhiza* is a widespread species of the western slopes and the margin of the arid zone, occurring in Queensland south from St George to around Bourke, Brewarrina and Walgett in New South Wales. The distribution of the other three species in the state is restricted to small areas in its south-eastern corner. *Craspedia paludicola* is known only from Girraween National Park, and *C. canens* from the same National Park and from some historical collections labelled as 'Stanthorpe'.

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References

Allan, H.H. (1961). *Flora of New Zealand. Volume 1. Indigenous Tracheophyta: Psilopsida, Lycopsida, Filicopsida, Gymnospermae, Dicotyledones*. New Zealand Government Printer: Wellington.

Bostock, P.D. & Holland, A.E. (2007). *Census of the Queensland Flora 2007*. Queensland Herbarium, Environmental Protection Agency: Brisbane.

—— (2010). *Census of the Queensland Flora 2010*. Queensland Herbarium, Department of Environment and Resource Management: Brisbane.

CHAH [Council of Heads of Australasian Herbaria] (2011). *Australian Plant Census*. http://www.anbg.gov.au/chah/apc/

Costin, A., Gray, M., Totterdell, C. & Wimbush, D. (2000). *Kosciuszko Alpine Flora*, 2nd edition. CSIRO Publishing: Melbourne.

Curtis, W.M. (1963). *The Student's Flora of Tasmania Part 2 – Angiospermae: Lythraceae to Epacridaceae*. St. David's Park Publishing: Hobart.

Everett, J. (1999). *Craspedia*. In N.G. Walsh & T.J. Entwisle (eds.), *Flora of Victoria* 4: 758–764. Inkata Press: Melbourne.

Everett, J., Doust, A.N.L. (1992a). New species and a new combination in *Pycnosorus* (Asteraceae: Gnaphalieae). *Telopea* 5: 39–43.

—— (1992b). Four new Australian species of *Craspedia* sens. strict. (Asteraceae: Gnaphalieae). *Telopea* 5: 35–38.

—— (1992c). *Craspedia*. In G.J. Harden (ed.), *Flora of New South Wales* 3: 221–226. NSW University Press: Sydney.

Everett, J. & Thompson, J. (1992). New alpine and subalpine species in *Craspedia* sens. strict. (Asteraceae: Gnaphalieae). *Telopea* 5: 45–51.

Ford, K.A., Ward, J.M., Smissen, R.D., Wagstaff, S.J. & Breitwieser, I. (2007). Phylogeny and biogeography of *Craspedia* (Asteraceae: Gnaphalieae) based on ITS, ETS and *psbA-trnH* sequence data. *Taxon* 56: 783–794.

Forster, G. (1786). *Florulae Insularum Australium Prodromus*. J.C. Dieterich: Göttingen.

McDougall, K.L. & Walsh, N.G. (2008). A conspectus of high-country *Craspedia* (Asteraceae: Gnaphalieae) of mainland south-eastern Australia. *Muelleria* 26: 3–10.

Rozefelds, A.C. (2002). A new species and new combination in *Craspedia* (Asteraceae) from Tasmania. *Telopea* 9: 813–820.

Rozefelds, A.C., Buchanan, A.M. & Ford, K.A. (2011). New species of *Craspedia* (Asteraceae: Gnaphalieae) from Tasmania and determination of the identity of *C. macrocephala* Hook. *Kanunnah* 4: 93–116.

Schmidt-Lebuhn, A.N. & Milner, K.V. (2013). A quantitative study of morphology in Australian *Craspedia* (Asteraceae, Gnaphalieae). *Australian Systematic Botany* 26: 238–254.

Stanley, T.D. & Ross, E.M. (1986). *Flora of south-eastern Queensland. Volume 2*. Queensland Department of Primary Industries: Brisbane.

Cullen spicigerum (Domin) A.E.Holland (Fabaceae), a new combination and reinstatement of a north Queensland species

Ailsa E. Holland

Summary

Holland, A.E. (2013). *Cullen spicigerum* (Domin) A.E.Holland (Fabaceae), a new combination and reinstatement of a north Queensland species. ***Austrobaileya* 9(1): 140–145.** *Psoralea spicigera* Domin has been relegated to synonymy under the Western Australian *Cullen lachnostachys* (F.Muell.) J.W.Grimes. This species is here reinstated and a new combination, *Cullen spicigerum* (Domin) A.E.Holland, is made. A revised description of this species is provided, along with notes on distribution and habitat and a key to the species of *Cullen* in Queensland.

Key Words: Fabaceae, *Cullen*, *Cullen spicigerum*, *Psoralea*, *Psoralea spicigera*, Australia flora, Queensland flora, identification key, taxonomy, new combination

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Introduction

Cullen Medik., tribe *Psoraleeae*, is a widespread genus of 32 species of which 26 occur in Australia (Grimes 1997; AVH 2013). The genus was revised by Grimes (1997) who placed *Psoralea spicigera* Domin in synonymy under *Cullen lachnostachys* (F.Muell.) J.W.Grimes, albeit without any explanatory notes as to why this decision was made. However, in his introduction, Grimes commented that "a couple of problems remain which will best be addressed through detailed field-work…There are several forms included in *C. badocanum* that might merit some taxonomic status, but which are incompletely known from few collections". It is possible that this taxon is referred to here, as Grimes probably saw only a few specimens and only one of the specimens cited below was mentioned anywhere in his revision (*Bolton 475* was determined by Grimes as *C. pustulatum* (F.Muell.) J.W.Grimes). Numerous new collections are all consistent with Domin's description of *Psoralea spicigera* except for the stipules which are generally shorter than the 1 cm described by him. The species is however quite distinct and the main differences are listed in **Table 1**. This north Queensland species is therefore here reinstated, and a new combination, *Cullen spicigerum* (Domin) Holland, is made.

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Materials and methods

This paper is based on herbarium collections in the Queensland Herbarium (BRI). The species was examined in the field in 2012. A common abbreviation in the specimen citations is: NP (National Park).

Taxonomy

Cullen spicigerum (Domin) A.E.Holland, **comb. nov.**; *Psoralea spicigera* Domin, *Biblioth. Bot.* 89(2): 186–187 (1926). **Type:** Queensland. Cook District: Elizabeth Ck [Creek], 16 July [1872], *W.Hann*, *Cape York Peninsula Expedition No. 40* (lecto: PR; isolecto: K, online image!; *fide* Grimes [1997: 615]).

Cullen sp. (Westmoreland C.H.Gittins 2491); Holland & Pedley (2013).

Erect herbaceous shrubs to 3 m tall; bark grey. Branches striate, densely pubescent with short crisped white or grey hairs, moderately glandular with large raised light brown or blond glands that are generally sunken or flush with surface or pustulate but generally not stipitate (see below). Leaves heteroblastic; the proximal leaves pinnately trifoliolate, the

Table 1. Comparison of morphological characters for *Cullen spicigerum* and putatively related taxa

Character state	*C. spicigerum*	*C. badocanum*	*C. pustulatum*	*C. lachnostachys*
indumentum	dense, short crisped	villose to lanate-villose	glabrate to villulose	velutinous or short-villose
stipule length (mm)	3–5	4–12	4–12	5–8.5
inflorescence shape	cylindrical	subglobose	cylindrical	cylindrical
inflorescence bract persistence	persistent	persistent	deciduous or persistent	deciduous
flower length (mm)	6–10	8.5–15	7–10	10.5–14.5
lower calyx lobe length (mm)	5–8	7.7–14	2.2–3.5	3.5–6.5
pedicel length (mm)	0.5–2	0.5–3	0.5–3	4–7

distal leaves unifoliolate; petioles 5–20 mm long; rachis 3–15 mm long; both petiole and rachis striate, pubescent and with scattered glands. Leaflets lanceolate, rounded to cuneate at base, acute or obtuse and apiculate at apex; the upper surface sparsely pubescent or nearly glabrous, with scattered glands; lower surface moderately densely pubescent, glandular with larger stipitate and crateriform glands congregated on the veins. Terminal leaflets 25–80 mm long; 8–35 mm wide, length:width ratio 1.8–4.4. Lateral leaflets similar, 2/3 of the length of the terminal leaflet. Stipules triangular, reflexed, 3–5 mm long, 1–1.5 mm wide, glandular and pubescent on outer surface, glabrous on inner surface, with several obscure veins. Stipels absent. Pseudoracemes indeterminate, one per axil, compact, cylindrical, occasionally branched, 1–10 cm long, 1.5–2 cm wide, initially shorter than the subtending leaf, longer at maturity; peduncle 20–80 mm long; rachis with 9–16 flowering nodes, initially shorter than the peduncle, elongating through the growing season. Flowers usually in pairs, rarely 3 together, overlapping on the rachis; internodes 2– 8 mm long. Bracts persistent, initially erect, becoming relaxed, broadly ovate to suborbicular, 3–6 mm long, 2.5–4.5 mm wide, the apex abruptly narrowed into a slightly reflexed acuminate tip; outer surface sparsely hairy mainly on the margins and densely covered in large, light brown pustular glands; inner surface glabrous. Bracteoles absent. Pedicels 0.5–2 mm long, pubescent. Flowers 6–10 mm long, corolla shorter or slightly longer than the calyx. Calyx tubular-campanulate, somewhat flattened, 7–10 mm long, 5-lobed, purplish-green, pubescent with short crisped white or grey hairs (sometimes tending to villous but not obscuring veins or glands); glands scattered, large, pustular; calyx tube 2–3 mm long, rounded at base, with 10 raised veins of which 5 end in the lobe sinuses and 5 continue to lobe apices; adaxial 4 lobes triangular, acute, 2–4 mm long, the uppermost two slightly longer and partly joined; abaxial lobe 5–8 mm long, carinate, curving upwards over the keel to a long attenuate point. Corolla glabrous, purplish at the apex and fading to white at base; standard obovate, 6–9 mm long, 6–7 mm wide, slightly longer than wings and keel, emarginate, tapered to an indistinct claw at base; wings

oblong, 8–9 mm long including a 2–3 mm claw, *c.* 2.5 mm wide, rounded at apex; keel upturned and enclosed in the other petals, *c.* 8 mm long including a 3–4 mm claw and 2 mm wide, rounded at apex and curved along the lower edge, the two halves joined in the distal half. Ovary glabrous, glandular, stipitate. Fruit and flower remnant falling together (excluding bract). Fruit stipitate; stipe to 3 mm long; pod broadly elliptic, flattened, 3–3.5 mm long, 1.7–2.3 mm wide, glabrous or with a few marginal hairs, very densely glandular with pustular glands, the fruit wall strongly adhering to the seed. Seed reniform, 2.3–2.5 mm long, 3.2–3.8 mm wide, smooth, green to light brown, hilum minute. **Fig. 1.**

***Additional specimens examined*: Queensland.** Cook District: 1 km N of Old Laura Homestead, Lakefield NP, Aug 2012, *Thompson ST12628* (BRI, MEL); near Old Laura Homestead, Lakefield NP, Jul 1993, *Stanton 2* (BRI); Lakefield NP, 3.5 km along 12 Mile Waterhole Road, Jul 2010, *McDonald KRM9701* (BRI, PE); *c.* 0.5 km from Kowanyama, Oct 1981, *Birchley 127* (BRI); Cooktown Development Road, *c.* 0.5 km E of Boggy Creek, Apr 2001, *Jago 5899 & Wannan* (BRI, MEL, NSW); Wrotham Park, Trimbles Crossing, Walsh River, May 2012, *McDonald KRM 12753 & Holland* (BRI); Murphy's Farm, Gilbert River, Aug 2001, *Smith AS2038* (BRI); Near Gamboola Homestead, N of Chillagoe, Aug 1985, *Bolton 475* (BRI); Van Lee Homestead, 65 km NNW of Mt Surprise, Jul 2001, *Addicott EPA873* (BRI); Gilbert River, May 1954, *Everist 5477* (BRI). Burke District: 14.5 km SE of Lotus Vale, on Lotus Vale to Stirling Road (Site 106), Jun 2001, *Turpin GPT592 & Thompson* (BRI); Westmoreland, 56 km from Wollogorang towards Burketown, Jul 1972, *Gittins 2491* (BRI). North Kennedy District: Cape Cleveland section of Bowling Green Bay NP, S of Townsville, Jul 1991, *Bean 3459* (BRI, MEL, MEXU).

***Distribution and habitat*:** *Cullen spicigerum* occurs in open woodland of *Corymbia*, *Eucalyptus* or *Melaleuca* usually with a grassy understorey and generally on alluvial silty clay or loam soils, often on river banks, flood plains or disturbed areas. The species is endemic to north Queensland where it is widespread on southern Cape York Peninsula and west nearly to the Northern Territory border (**Map 1**).

***Phenology*:** This species flowers and fruits continuously through the cooler months from April through to August, occasionally as late as October.

***Notes*:** *Cullen spicigerum* is related to the widespread *C. badocanum* (Blanco) Verdc. and *C. pustulatum*, and the Western Australian endemic *C. lachnostachys*. It differs from *C. badocanum* by the cylindrical pseudoracemes and the shorter stipules, flowers and abaxial calyx lobe, and from *C. pustulatum* by the dense indumentum (especially on the calyx), shorter pseudoracemes, shorter stipules and much longer abaxial calyx lobe. It differs from *C. lachnostachys* by the persistent and smaller bracts, the shorter pedicels, flowers and stipules, and the shorter pubescence (especially on the calyx) and the longer abaxial calyx lobe.

***Conservation status*:** *Cullen spicigerum* is **Least Concern** using the IUCN (2001) criteria.

Key to the species of *Cullen* in Queensland

1 Leaflets 3 or 5, palmately arranged . . . . . **C. tenax**
1. Leaflets 3, pinnately arranged, or leaves unifoliolate **2**

2 Plants covered in long spreading white hairs > 1 mm long; bracts lanceolate and more than 6 mm long . . . . . **C. plumosum**
2. Plants glabrous or if hairs present then < 1 mm long; bracts ovate to orbicular, less than 6 mm long **3**

3 Leaves all unifoliolate **4**
3. Leaves trifoliolate, or both unifoliolate and trifoliolate leaves present **6**

4 Inflorescence an elongate spike; calyx shorter than the fruit . . . . . **C. leucanthum**
4. Inflorescence subglobular on a shortened rachis; calyx longer than the fruit **5**

5 Whole plant densely covered in black pustular glands; leaves distinctly denticulate; flowers to 7 mm long . . . . . **C. balsamicum**
5. Sparsely to moderately glandular with brown glands and flush with surface; leaves entire or weakly toothed; flowers 9–15 mm long . . . . . **C. badocanum**

6 Glands on stems and petioles pustular or stipitate **7**
6. Glands on stems and petioles flush with surface, or sunken **8**

7 Calyx much shorter than corolla, the hairs confined to veins; abaxial calyx lobe scarcely longer than the others . . . . . **C. pustulatum**
7. Calyx longer or shorter than corolla, moderately hairy; abaxial calyx lobe c. 3 mm longer than the others . . . . . **C. spicigerum**

8 Leaflets mostly more than 5 cm long, lanceolate, entire **9**
8. Leaflets mostly less than 5 cm long, ovate to lanceolate, denticulate, dentate, erose or serrate **10**

9 Plants glabrous or nearly so; corolla much longer than calyx, predominantly white, cream or yellowish with a purple blotch . . . . . **C. leucanthum**
9. Plants hairy to some degree; corolla as long or slightly shorter than calyx, purple to white . . . . . **C. spicigerum**

10 Calyx 2–4 mm long, shorter than the fruit . . . . . **C. cinereum**
10. Calyx 3–8 mm long, longer than the fruit **11**

11 Calyx sparsely hairy with appressed white hairs in rows, and much longer than corolla . . . . . **C. graveolens**
11. Calyx densely hairy with spreading or appressed white or black hairs, and shorter than or equal to corolla **12**

12 Inflorescence condensed, usually shorter than the subtending leaf; peduncles less than 4 cm long; corolla usually white . . . . . **C. discolor**
12. Inflorescences elongated and interrupted, much longer than the subtending leaf; peduncles longer than 4 cm; corolla usually purple, pink or blue **13**

13 Plants strictly prostrate . . . . . **C. patens**
13. Plants erect or ascending, bushy **14**

14 Entire plants densely white velvety hairy, the glands of the leaves obscured . . **C. pallidum**
14. Only calyces with dense white hair; the glands on the leaves apparent . . **C. australasicum**

Acknowledgements

I would like to thank Les Pedley for drawing this species to my attention and Keith McDonald for his excellent specimens, information and on ground guidance. I also acknowledge Ruth Clark who located the isolectotype at Kew and arranged for an image to be provided. Will Smith prepared the illustrations and map.

References

AVH (Australia's Virtual Herbarium) (2013). Council of Heads of Australasian Herbaria, viewed 16 August 2013, <http://avh.ala.org.au/>

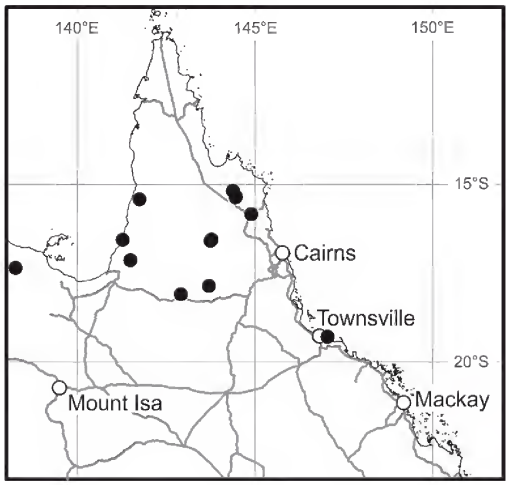
Domin, K. (1926). *Psoralea* L. *Bibliotheca Botanica* 89(2): 186–187.

Grimes, J.W. (1997). A revision of *Cullen* (Leguminosae: Papilionoideae). *Australian Systematic Botany* 10: 565–648.

Holland, A.E. & Pedley, L. (2013). Fabaceae. In P.D. Bostock & A.E. Holland (eds), *Census of the Queensland Flora 2013*. Queensland Herbarium, Department of Science, Information Technology, Innovation and the Arts: Brisbane. https://data.qld.gov.au/dataset/census-of-the-queensland-flora-2013

Iucn (2001). *Red List Categories and Criteria: Version 3.1*. IUCN Species Survival Commission. IUCN: Gland, Switzerland/Cambridge, U.K.

Fig. 1. ***Cullen spicigerum.*** A. branch ×1. B. leaflet lower surface ×16. leaflet upper surface ×16. D. stipule ×8. E. bract ×8. F. calyx ×6. G. standard petal ×6. H. keel petal ×6. I. wing petal ×6, J. staminal column ×6. K. ovary and style enclosed in staminal column ×6. L. fruit ×8. K. seed ×8. All from *McDonald KRM9701* (BRI). Del. W.Smith.



Map. 1. Distribution of *Cullen spicigerum* in Queensland.

SHORT COMMUNICATION

Celtis strychnoides Planch. an earlier name for *Celtis australiensis* Sattarian (Ulmaceae)

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Celtis australiensis Sattarian was described by Sattarian (2005) as occurring in north west Western Australia, the Northern Territory and north west Queensland and was distinguished from *Celtis philippensis* Blanco by its elliptic, cordate, pilose leaves (2–7 × 1.5–5 cm), spinose leaf apices and margins. This name has subsequently been incorrectly applied to all Australian specimens previously known as *Celtis philippensis* (CHAH 2007). Sattarian (2005) referred to the *Flora of Australia* treatment of *Celtis* by Hewson (1989) but overlooked the name *Celtis strychnoides* Planch. given by Hewson as a synonym of *Celtis philippensis*.

Planchon (1848) described *Celtis strychnoides* from a collection of Allan Cunningham's from Careening Bay, Kimberley, northern Western Australia. He distinguished it from *Celtis philippensis* by its small, pubescent, ovate or rarely broadly ovate leaves that were barely 1.5 inches (4 cm) long.

Examination of the type collections and images of *Celtis strychnoides*, *C. australiensis* and specimens of *Celtis* at BRI, MEL and NSW confirm that *C. strychnoides* is conspecific with *C. australiensis* and as such is the earlier name.

Celtis strychnoides Planch., *Annales des Sciences Naturelles, Botanique* ser. 3, 10: 306–307 (1848). **Type:** [Western Australia] Careening Bay, north west Australia, January 1820, *A. Cunningham 193* in herb. Hook. (holo: K [852750, 852752 images !] , iso: BM [838618, 838619, 799835 images !], BRI *p.p.*, MEL *p.p.*).

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Celtis australiensis Sattarian, *Blumea* 50: 499 (2005), **synon. nov. Type:** Western Australia. Northern Province: Geikie Gorge, near gorge mouth, 14 May 1992, *I. Telford 11722* (holo: CANB *n.v.*; iso: BISH *n.v.*, BRI, L *n.v.*, NSW, PERTH *n.v.*).

***Illustration*:** Sattarian & van der Maesen (2005: 500, Fig. 1).

***Additional specimens examined*: Western Australia**. N end of Bougainville Peninsula, Apr 1982, *Kenneally 8076* (BRI); Walsh Point, Port Warrender, May 1981, *Tracey 15170, 15075* (BRI); Port Warrender, Oct 1974, *Rodd 2900* (NSW); Surveyor's Creek Road, May 1981, *Tracey 15122* (BRI); Lone Dingo, May 1981, *Tracey 1500* (BRI); Merten's Falls, May 1981, *Tracey 15062* (BRI); Near Crusher Pool, May 1981, *Tracey 15233* (BRI); Cambridge Gulf, in 1886, *Ranford & Nyulasy 18 & 36* (MEL); Wyndham, in 1903 & Nov 1906, *Fitzgerald s.n.* (NSW); Cockburn Range, 13 km W of King River, July 1974, *Carr 3316 & Beauglehole 47094* (NSW); 4 km S of junction of Neville Creek & Calder River, May 1983, *Fell 9* (BRI); Cape Leveque, Jul 1973, *Webb & Tracey 13141* (BRI); King's [King] Sound, in 1869, *Hughan s.n.* (MEL 2210491, 2210489, 2210481); *ditto,* in 1888, *Froggart s.n.* (NSW); Napier Range, Jul 1973, *Tracey 14807* (BRI); Mornington Wildlife Sanctuary, NE of Fitzroy Crossing, Apr 2005, *Murphy MULE453 & Legge* (BRI); Geikie Gorge, 16 km NE of Fitzroy Crossing, Jun 1970, *Briggs 3671* (NSW); *ditto,* May 1981, *Tracey 15143* (BRI); 10 miles [16 km] SW of Lissadell Station, Aug 1949, *Perry 2672* (MEL); S of Ord River Station, Aug 1973, *Tracey 14100* (BRI). **Northern Territory.** Victoria River, Dec 1855, *Mueller s.n.* (K 852751, MEL 2210482, 2210475); Limestone Gorge, Gregory NP, Apr 1990, *Evans 3091* (MEL); Gregory NP, Apr 1996, *Booth 1696* (MEL); *ditto*, Apr 1996, *Duretto 1187* (MEL); *ditto*, Apr 1996, *Foreman 2249* (MEL); *ditto*, Apr 1996, *Jones 83* (MEL); 5 km S of Timber Creek, May 1983, *Briggs 904* (MEL); 15 miles [24 km] SSE of Timber Creek, Jun 1952, *Perry 2869* (BRI); 41 km SSE of Turkey Creek, Jul 1984, *Scarlett 84-334* (MEL); 6 miles [10 km] NW of Katherine, *Adams 806* (NSW); 11 miles [18.3 km] S of Katherine, Feb 1961, *McKee 8487* (NSW); 16-Mile Cave Reserve, S of Katherine, May 1978, *Webb & Tracey 12588* (BRI); 4 miles [6 km] E of Elsey, Oct 1958, *Chippendale 5065* (BRI, NSW); 15 miles [24 km] S of MacArthur River Station, Jul 1949, *Perry 1732* (BRI,

MEL); near head of Kilgour River, Sep 1911, *Hill 556* (MEL); Settlement Creek, Jun 1922, *Brass 161* (BRI). **Queensland.** BURKE DISTRICT: 39 km SW of Hells Gate, Apr 2006, *Thompson WES384 & Edginton* (BRI); 17 km W of Adel's Grove, Lawn Hill NP, Nov 1983, *Puttock UNSW14474 & St George* (MEL); 20.2 km S of Musselbrook, Apr 1995, *Thomas & Johnson MRS469* (BRI); Lawn Hill NP, May 1988, *O'Keefe 11* (BRI); 1 km N of Gregory River, Riversleigh, May 1970, *Webb & Tracey 1349* (BRI); 29 km NW of Norfolk Station, Apr 2005, *Kelman DTK1021* (BRI); Seymour River, vicinity of Nicholson River, Jul 1886, *Dittrich s.n.* (BRI [AQ88147]); 7 km NE of Camooweal, Jul 2006, *Booth CAM29-1 & Kelman* (BRI).

***Distribution*:** *Celtis strychnoides* occurs in the Kimberley region of northern Western Australia, central northern Northern Territory and north western Queensland.

***Habitat*:** The species occurs in semi-deciduous notophyll vine thickets or woodlands usually in rocky situations on slopes or hills in fire refugia, on limestone, basalt or sandstone.

***Notes*:** The Northern Territory and Queensland collections from higher rainfall areas (>1100 mm mean annual rainfall) that have glabrous, ovate or oblong leaves 6–18 × 3.5–8.5 cm and that were included in *C. australiensis* by CHAH (2007) are referrable to *Celtis philippensis*. These collections may represent a species distinct from *C. philippensis* but a revision of this species complex is required to resolve the taxonomy.

The Cunningham sheets at BRI and MEL include specimens of both *C. strychnoides* and *C. philippensis*.

Celtis strychnoides can be distinguished from Australian material of *Celtis philippensis* by the following key:

1 Leaf blades ovate or broadly ovate, acute, 2–7 × 1.5–4 cm, young leaves sparsely pubescent, glabrescent except veins and leaf base below; base rounded or cordate; petioles and branchlets pubescent with white erect hairs 0.1–0.3 mm long, petioles 3–6 mm long; juvenile leaves with spinose margins, occasionally adult leaves with short marginal spines; small tree to 4–8 (–10) m. WA, NT & NW Qld . . . . . **Celtis strychnoides**

1. Leaf blades oblong to ovate, acuminate, 6–18 × 3.5–8.5 cm, glabrous; base cuneate to truncate; petioles glabrous, occasionally sparsely pubescent, 5–8 mm long; juvenile leaves with serrate or crenate margins; tree 4–25 m. Coastal NT & N & E Qld. . . . . **Celtis philippensis**

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I thank the Directors and staff of MEL and NSW for allowing access and examination of their collections.

References

CHAH (2007). *Australian Plant Census*. Council of Heads of Australasian Herbarium, http://www.anbg.gov.au/chah/apc/

HEWSON, H.J. (1989). Ulmaceae. In A.S. George (ed.), *Flora of Australia* 3: 10–13. Australian Government Publishing Service: Canberra.

PLANCHON, J.E. (1848). Sur les Ulmacées, *Celtis*. *Annales des Sciences Naturelles, Botanique* ser. 3, 10: 283–316.

SATTARIAN, A. & VAN DER MAESEN, L.J.G. (2005). Two new species of *Celtis* (Celtidaceae) from Australia and Madagascar. *Blumea* 50: 499–503.

SHORT COMMUNICATION

Reinstatement of *Rapanea leucobrachya* P.Royen (Myrsinaceae) from New Guinea, with a new combination as *Myrsine leucobrachya* (P.Royen) P.I.Forst.

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Van Royen (1982) named a number of new species of *Rapanea* Aubl. from montane areas of New Guinea. Many of these were subsequently reduced to synonymy by Sleumer (1986) when he revised the New Guinea species. The New Guinea species recognised by Sleumer (1986) were uncritically transferred to *Myrsine* L. by Pipoly (Takeuchi & Pipoly 2009), together with the addition of one new species (*Myrsine warrae* W.N.Takeuchi & Pipoly).

During curation of New Guinea Myrsinaceae at BRI it became obvious that Sleumer's treatment of certain *Myrsine* species was overly conservative. This pertained particularly to his reduction to synonymy of *Rapanea leucobrachya* P.Royen and *R. wapu* P.Royen under *R. rhombata* P.Royen without any accompanying reasons. Whilst the recognition of three species for this group of montane populations from the Eastern and Western Highlands of Papua New Guinea may be too liberal, recognition of only one is not supported by easily discernible morphological differences such as leaf shape, venation and gland morphology. Hence, two species, *M. rhombata* (P.Royen) Pipoly and *M. leucobrachya* (P.Royen) P.I.Forst. are recognised herein.

Myrsine rhombata (P.Royen) Pipoly, *Edinburgh J. Bot.* 66: 462 (2009); *Rapanea rhombata* P.Royen, *Alpine Fl. New Guinea* 3: 1976 (1982). **Type:** Papua New Guinea. Eastern Highlands Province: Mt Wilhelm, east slopes, 28 July 1959, *L.J.Brass 30757* (holo: L, online image!; iso: US, online image!).

***Specimens examined*: Papua New Guinea.** Eastern Highlands Province: Kurumigl-bokwa, Kuski River above Toromambuno Mission, Upper Chimbu, Aug 1957, *Pullen 324* (BRI); Mt Wilhelm, Lake Piunde, Aug 1957, *Robbins 684* (BRI). Western Highlands Province: track to Mt Hagen, E of Mt Kigum, Apr 1977, *Vinas & Veldkamp LAE59812* (BRI). Central Province: Murray Pass, Wharton Range, Jun–Sep 1933, *Brass 4546* (BRI); Murray Pass, Aug 1970, *Foreman & Lelean NGF48412A* (BRI); Mt Victoria area, Iawan Swamp, *c.* 2 km SSW of Mt Service, May 1976, *van Royen 11033* (BRI).

Myrsine leucobrachya (P.Royen) P.I.Forst. **comb. nov.**; *Rapanea leucobrachya* P.Royen, *Alpine Fl. New Guinea* 3: 1975 (1982). **Type:** Papua New Guinea. Southern Highlands Province: Mt Ialibu, slope to SW of Repeater Station, 10 August 1972, *P.F.Stevens & D.B.Foreman LAE55853* (holo: K, online image!; iso: BRI; L, online image!).

Rapanea wapu P.Royen, *Alpine Fl. New Guinea* 3: 1971 (1982), **synon. nov. Type:** Papua New Guinea. Western Highlands Province: Northern slope of Sugarloaf complex (along Wapu River), 21 July 1960, *R.D.Hoogland 7232 & R.Schodde* (holo: L, online image!; BM, online image!).

***Additional specimens examined*: Papua New Guinea.** West Sepik Province: Bielga Range, W of Folongonom, second camp below Tamanagabip on Busilmin Track, May 1975, *Vinas & Wiakabu LAE59529* (BRI). Eastern Highlands Province: track to Mt Michael, 5 km SW of Lufa, Apr 1982, *Kairo 458* (BRI). Western Highlands Province: around the base camp, Mt Kigum, Apr 1977, *Vinas & Veldkamp LAE59836* (BRI). Central Province: E slope to Lake Myola No 1, Sep 1973, *Croft & Lelean NGF34965* (BRI).

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The two species can be distinguished by the following key.

Lamina rhombate-obovate, tip acuminate to retuse, below with numerous elongate glands, round glands along margins; 2° lateral veins obscure or very indistinct, 9–12 per side of 1° vein (midrib). Bracteoles broadly ovate to elliptic-ovate, 1–1.5 × 0.8–1.2 mm. . . . . **M. rhombata**

Lamina elliptic, rhombate-elliptic to obovate, tip acuminate to obtuse, below with numerous nail-like glands on either side of 1° vein; 2° lateral veins prominent and easily discernible above and below, 8–14 per side of 1° vein (midrib), joined and forming an intramarginal vein, 3° veins prominent and reticulate below. Bracteoles ovate, 0.8–2.2 × 1–1.2 mm . . . . . **M. leucobrachya**

References

Sleumer, H. (1986). A revision of the genus *Rapanea* Aubl. (Myrsinaceae) in New Guinea. *Blumea* 31: 245–269.

Takeuchi, W. & Pipoly, J. (2009). Nomenclatural transfers in East Malesian *Myrsine* (Myrsinaceae), and the description of *M. warrae*, a distinctive new species from ultrabasic environments in Papua New Guinea. *Edinburgh Journal of Botany* 66: 459–467.

Van Royen, P. (1982). *The Alpine Flora of New Guinea*. Volume 3: taxonomic part Winteraceae to Polygonaceae. J. Cramer: Vaduz.

SHORT COMMUNICATION

Emmenosperma pancherianum Baill. (Rhamnaceae) newly recorded for Australia

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Emmenosperma F.Muell. is a genus of five species found in northern and eastern Australia, New Guinea, Sulawesi, New Caledonia and Fiji. It was described by Mueller (1862) based on *Emmenosperma alphitonioides* F.Muell. from Australia. Soon after, Bentham (1863) described another Australian species, *E. cunninghamii* Benth. Baillon described *E. pancherianum* Baill. from New Caledonia in 1874. In the 20th century, two additional species, originally described in the genus *Colubrina* Rich. ex Brongn., were transferred to *Emmenosperma*, *viz. E. micropetalum* (A.C.Sm.) M.C.Johnst. and *E. papuanum* (Merr. & L.M.Perry) M.C.Johnst.

In 2005, an unusual *Emmenosperma* specimen was submitted to the Queensland Herbarium, collected from Mt Zero–Taravale Sanctuary near Townsville. It was very unlike the two well-known Australian species, and an ensuing literature search suggested a strong affinity with *E. pancherianum*. Flowering and fruiting material was obtained from the Mt Zero–Taravale population in 2009, and this material has been compared with specimens of *E. pancherianum* collected from New Caledonia. The comparison revealed that there are no significant morphological differences between the New Caledonian material and the Mt Zero–Taravale material.

Emmenosperma pancherianum Baill., *Adansonia* 11: 269 (1874). **Type citation:** 'in Austro-Caledonia ubi in sylvis collium [hill-forests of southern Caledonia], leg. Pancher (herb.)'. **Type:** Nouvelle Caledonie, May 1865, *J.A.I. Pancher s.n.* (lecto: P 06886541 [here chosen]).

***Illustration*:** Sprague (1915: t. 3027).

Shrub or small tree to 5 m. Young branches with dense indumentum of appressed simple hairs, older branches glabrous. Stipules caducous, hairy, triangular, *c.* 0.8 mm long. Leaves 16–40 × 8–22 mm, lamina obovate, with 2–4 obscure pairs of lateral veins at 45–70° to midrib, base cuneate, apex obtuse or emarginate; upper surface glabrous (except at base on midrib), very glossy; lower surface less glossy, glabrous; petioles 1.5–4 mm long, with appressed hairs. Inflorescences axillary, borne on short lateral branchlets 2–5 mm long with rusty hairs near apex; rachises absent or up to 2 mm long. Flowers 5-merous. Hypanthium and sepals with antrorse appressed brownish hairs; sepals deltate, 1–1.2 mm long, obtuse. Petals elliptical, 0.9–1.1 mm long, white, glabrous, hooded. Ovary glabrous, disc inconspicuous at base of ovary; style bulbous, 0.6–0.8 mm long, 2-lobed at apex. Fruiting pedicels sparsely hairy, 2.5–5(–6.5) mm long; fruits ± globose, 5–6 mm long, 2-locular; endocarpids 2, splitting longitudinally from the apex for up to half their length. Seeds flattened ellipsoidal, 4–5.7 mm long, surface smooth and shiny, orange to red, remaining attached to fruiting pedicels after endocarpids have been shed.

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***Additional specimens examined*: New Caledonia:** Nékoro, Aug 2003, *Dagostini & Rigault 703* (NOU); Gouaro Deva, Oct 2005, *Dagostini 979* (NOU); Noumea, Jun 1909, *Franc 1382* (BRI); Noumea, presqu'île Ducos, Apr 1970, *McKee 21778* (NOU); Tontouta, Jul 1971, *McKee 24789* (NOU); Ngoué, Paita, Mar 1981, *McKee 38781* (NOU); Plaine des gaiac, Jul 1987, *Veillon 6411* (NOU); Mt Tereka, Noumea, Jul 1991, *Veillon 7405* (NOU); Poya-Nord, Oct 1998, *Veillon 8134* (NOU). **Australia: Queensland.** North Kennedy District: Near Return Creek falls, 'Taravale', NW of Townsville, May 2009, *Bean 28865 & Jensen* (BM, BRI, CANB, CNS, MO, NSW, P); Return Creek Falls, 'Taravale', 80 km WNW of Townsville, Jul 2005, *Cumming s.n.* (BRI [AQ612648]). **Cultivated**. Botanic Gardens, Sydney, Jan 1921, *White s.n.* (BRI [AQ23692]).

***Distribution and habitat*:** This species is distributed along the west coast of New Caledonia, between Koumac and Noumea (Barrault 2006). In Australia, it is known from a single population at Mt Zero–Taravale Sanctuary north-west of Townsville, Queensland. In New Caledonia, it inhabits the "dry forests" of the western coast (Barrault 2006), a habitat that has been decimated for grazing and agriculture (Hequet 2010). In Queensland, it grows on the steep south-facing slope of a granite ridge, in open forest dominated by *Araucaria cunninghamii* Mudie and *Eucalyptus granitica* L.A.S.Johnson & K.D.Hill.

***Phenology*:** Flowers April to October; fruits September to March.

***Typification*:** The protologue specified 'Pancher' as the collector. Several Pancher specimens at P predate the publication date. P 06886541 was chosen as the lectotype because it is a very good flowering specimen, and attached to the sheet is a handwritten description of the species, most likely by the author of the name.

***Notes*:** *Emmenosperma pancherianum* provides one more instance of the well known floristic connection between tropical eastern Australia and New Caledonia (Morat *et al.* 1986; Ladiges & Cantrill 2007).

While a large proportion of New Caledonian plant species are endemic, there are numerous examples of species that occur in both New Caledonia and eastern Australia. These include not only littoral species that are dispersed by ocean currents e.g. *Premna serratifolia* L. and *Cerbera manghas* L., but others such as *Carissa ovata* R.Br., *Croton insularis* Baill., *Drypetes deplanchei* (Brongn. & Gris) Merr., *Polyalthia nitidissima* (Dunal) Benth., *Psydrax odorata* (G.Forst.) A.C.Sm. & S.P.Darwin, *Pterocaulon serrulatum* (Montrouz.) Guillaumin and *Rhamnella vitiensis* (Benth.) A.C.Sm.

***Conservation status*:** *Emmenosperma pancherianum* is listed as 'Vulnerable' under the criteria of the IUCN Red List, based on its New Caledonian occurrence (Hequet 2010). In Australia, it is currently known from a single population comprising between six and 10 individuals. Its recommended status, based on the Australian population only, is **Critically Endangered**, Criterion D (IUCN 2001).

Key to the species of *Emmenosperma* in Australia

1 Inflorescences axillary, borne in dense ± spherical clusters, rachises lacking or < 2 mm long; petioles 1.5–4 mm long *Qld*, *New Caledonia* . **E. pancherianum**

1. Inflorescences predominantly terminal, some in upper leaf axils, paniculate to corymbose, rachises 13-70 mm long; petioles 5–27 mm long **2**

2 Bracts and bracteoles conspicuous at anthesis; style 2-fid; fruiting pedicels (3–)4–5.5 mm long; fruits 2-locular *Qld*, *NSW* . . . . . **E. alphitonioides**

2. Bracts and bracteoles inconspicuous at anthesis; style 3-fid; fruiting pedicels 1.5–2.5(–4) mm long; fruits 3-locular *Qld*, *NT*, *WA*, *New Guinea* . . . . . **E. cunninghamii**

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References

Barrault, J. (2006). *Plantes des Forêts Sèches de Nouvelle-Calédonie*. Programme Forêts Sèches et Centre d'Initiation à l'Environnement: Noumea.

Bentham, G. (1863). *Emmenosperma*. In *Flora Australiensis* 1: 414–415. L.Reeve: London.

Hequet, V. (2010). *Emmenosperma pancherianum*. In *IUCN Red List of Threatened Species*. Version 2012.2. <www.iucnredlist.org>. Downloaded on 20 October 2012.

Iucn (2001). *Red List Categories and Criteria: Version 3.1*. IUCN Species Survival Commission. IUCN: Gland, Switzerland/Cambridge, U.K.

Ladiges, P.Y. & Cantrill, D. (2007). New Caledonia – Australian connections: biogeographic patterns and geology. *Australian Systematic Botany* 20: 383–389.

Morat, P., Veillon, J.-M. & Mckee, H.S. (1986). Floristic relationships of New Caledonian rainforest phanerogams. *Telopea* 2: 631–679.

Mueller, F. (1862). *Emmenosperma*. *Fragmenta Phytographiae Australiae* 3: 62–63. Government Printer: Melbourne.

Sprague, T.A. (1915). *Emmenosperma pancherianum*, Baill. *Hooker's Icones Plantarum* 31: t. 3027.

SHORT COMMUNICATION

Euphorbia operta Halford & W.K.Harris (Euphorbiaceae), a new name for *Euphorbia occulta* Halford & W.K.Harris, *nom. illeg.* and lectotypification of the name *Euphorbia australis* var. *subtomentosa* Domin

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In our recent taxonomic treatment of *Euphorbia* section *Anisophyllum* Roeper (Euphorbiaceae) in Australia (Halford & Harris 2012) we incorrectly published the name *E. occulta* Halford & W.K.Harris for an endemic Australian species from northwest Queensland. We were unaware that the name had already been applied by Klotzch (1856) to a North America species, so the use of the name by us was illegitimate, being a much later homonym. Therefore a new name *Euphorbia operta* Halford & W.K.Harris is provided here for the Australian species. The specific epithet is from Latin, *opertus*, hidden from sight, concealed, in reference to the concealment of the involucral glands by the erect hood-like gland appendages of this species.

Euphorbia operta Halford & W.K.Harris, **nom. nov.**; *Euphorbia occulta* Halford & W.K.Harris, *Austrobaileya* 8: 529–530 (2012), ***nom. illeg.***, *non* Klotzsch, *Bot. Voy. Herald* [*Seemann*] 7–8: 277 (1856). **Type:** Queensland. Burke District: 12.3 km along Lake Moondara Road from Barkly Highway, N of Mt Isa, 1 July 2011, *D. Halford QM524A* (holo: BRI, iso: DNA, K, MEL, MICH, NT, *distribuendi*).

We also overlooked the need to lectotypify the name *Euphorbia australis* var. *subtomentosa* Domin in order to fix the application of this name. Domin's (1927) description of *E. australis* var. *subtomentosa* was based on material collected by Dr E. Clement from between the Ashburton and De Grey Rivers in Western Australia. There are four sheets that were seen by Domin, one in PR [528303] and three in K [186468, 186496, 186467]. These comprise all the original material for the name that we have been able to locate. Careful examination of the four sheets clearly indicated that the specimens affixed to them belong to two different taxa, namely those currently known as *E. australis* var. *subtomentosa* (K 186468, PR 528303 (lower two fragments)) and *E. vaccaria* Baill. var. *vaccaria* (K 186496, 186467, PR 528303 (upper three fragments)). There is little doubt that all the material was used by Domin in his formulation of the original description of *E. australis* var. *subtomentosa*. The specimen numbered K 186468 is selected here as lectotype of *E. australis* var. *subtomentosa*. If either of the sheets (K 186496, 186467) or fragments (PR 528303 (upper three fragments)) were chosen as lectotype, *E. australis* var. *subtomentosa* would have to be placed in synonymy under *E. vaccaria* and a new name would be required for what is currently known as *E. australis* var. *subtomentosa*.

Euphorbia australis var. **subtomentosa** Domin, *Biblioth. Bot.* 89(4): 310 (1927 '1926'). **Type:** Western Australia. Inter Ashburton et De Gray [Grey] River *s.d.*, *E. Clement s.n.* (lectotype [here chosen]: K 186468; isolecto: PR 528303 (lower two fragments)).

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References

Domin, K. (1927). *Euphorbia* L. In Beiträge zur Flora und Pflanzengeographie Australiens, 1. Tiel, 3. Abt. *Bibliotheca Botanica* 89(4): 306–312.

Halford, D.A. & Harris, W.K. (2012). A taxonomic revision of *Euphorbia* section *Anisophyllum* Roeper (Euphorbiaceae) in Australia. *Austrobaileya* 8: 441–600.

Klotzsch, J.F. (1856). Euphorbiaceae. In B.C. Seemann, *Botany of the Voyage of H.M.S. Herald, under the Command of Captain Henry Kellett, R.N., C.B., during the years 1845-1851*, pp. 276–278. L. Reeve: London.